# 13.2 Uli Gösele: His Random Walk Through Science

**(with pictures)**

## 1. Introduction

A **random walk,** also known as **drunken sailor walk,** is usually described like this: Some guy comes out of a bar or the Max-Planck Institute, drunken or confused in a major way, and is ready to do the drunken sailor walk. This is the start or **nucleation** of the random walk. We actually still have an original picture of this event for our esteemed friend and colleague **Ulrich Gösele**[1)] as shown in **Fig. 1**.

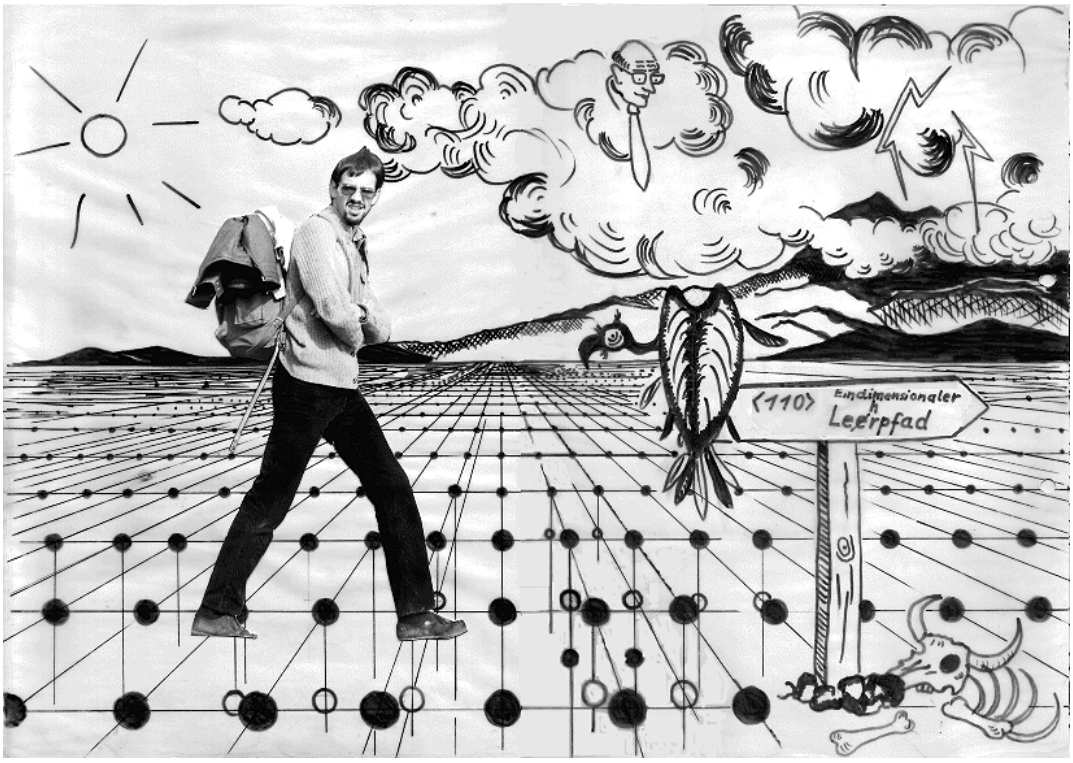



***Fig. 1*** *Uli Gösele starts his Random Walk*

Note that that a close associate of **God**[2)] is watching this; obviously with some doubts about the outcome.

After the start the random walker moves in a more or less straight line like a **crowdion** until he hits a true or imagined obstacle that changes his course in a random



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

fashion. Scientifically we call this a **scattering event** that happens at some **scattering center.** The scattering process, if analyzed in some detail, allows conclusions about the internal structure of the scattering particles; i.e. about the nature and the internal workings of the entity **Ulrich Gösele** or **Uli** for short.

After some time of these peregrinations the drunken sailor disappears somehow. He might, for example, just lie down and go to sleep; sometimes in a ditch, sometimes in a bed, either as singulet or possibly as duplet, taking a suitable scattering center down with him. Not only the pope in this case forbids the triplett configuration; three particle collisions are also exceedingly rare in random walk physics.

The random walk has come to an end some distance from the starting point. **Fig. 2** schematically summarizes this.

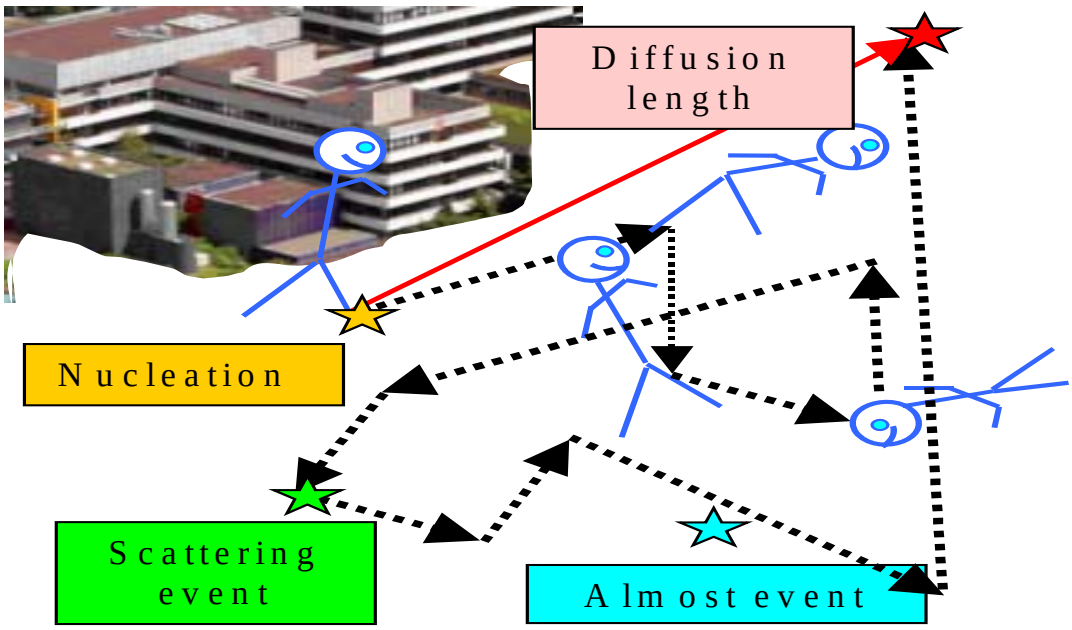



***Fig. 2*** *Schematics and definitions concerning random walk*

What I will address in this scientific contribution to the field of **Göselelogy** (or **Göselogy** for short) is:

**Part 1: Nucleation.** How and when did Uli Gösele get out of the Max-Planck-Institute (MPI) for Metal Physics in Stuttgart as a **randomly migrating scientist**? How did he get inebriated or otherwise confused in there? Of course, we are also interested in how he happened to get into the MPI in the first place. And what the f… is a crowdion[3)]?

**Part 2: Scattering Events.** After U. Gösele was finally launched, uncontrollable i.e. random scattering events lead to sudden changes of his direction and thus produced randomness. In this part I will focus on the nature of some of the **scatter-**



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company
H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*
Received 19 January 1977

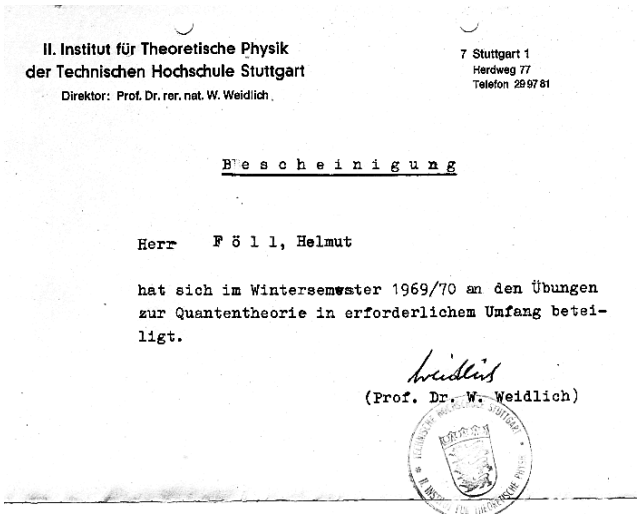
**ing centers** he encountered. For example, electrons in metals are mostly scattered at phonons and defects, while for budding male scientists major scattering partners seem to be other scientists, accidents, and the females of the species. However, in contrast to electrons, in Göselogy we must also consider near misses, i.e. events where actually no direct scattering took place even so he got very close to a potent scattering center. This is like quantum theory where the final outcome of an experiment also depends not only on what did happen but also on what could have happened in between.

**Part 3: Diffusion length.** Finally we are interested in the diffusion length, meaning how far on average the random walker will get before his random walk is over. Usually this is a number measured in meters but in Göselogy we must use other metrics, like the number of publications, the number of citations, or something else that can be used as a adequate measure of distance from the origin.

## 2. Nucleation

In a very strict sense primary nucleation – strictly **hetero**geneous in his case - must have occurred sometime in the spring of 1948, followed on Jan. 26th 1949, after some kind of Ostwald ripening, by a violent act of phase separation involving his mother.

We will, however, not dwell on the initial growth period of the **infan**t Uli Gösele but skip 20 years or so and look at the nucleation of the **scientist** Uli Gösele. That was a gradual process, starting around **1968**.



II. Institut für Theoretische Physik
der Technischen Hochschule Stuttgart
Direktor: Prof. Dr. rer. nat. W. Weidlich

7 Stuttgart 1
Herdweg 77
Telefon 28 97 81

B e s c h e i n i g u n g

Herr F ö l l, Helmut

hat sich im Wintersemester 1969/70 an den Übungen zur Quantentheorie in erforderlichem Umfang beteiligt.

(Prof. Dr. W. Weidlich)

***Fig. 3*** *I made it – thanks to Uli!*

Some of you - the older ones - might remember 1968 as the remarkable year when the number of publications concerning Silicon exceeded for the first time those for iron and steel.

We younger guys remember it because of the **students rebellion** and, far more important, the **sexual revolution** that also started around then.

However, since fledgling physicists are usually not too rebelliously inclined, we missed some of the fun - like torching American Embassies or whatever else one did for major entertainment in those years. Far worse,



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

there were practically no females studying physics to celebrate the sexual revolution with, not to mention that quantum theory was looming on the horizon as a major required lecture course.

My first memory of bumping into Uli Gösele is copying the solutions to the quantum mechanics exercise questions from him. He could do it; I couldn't. With his help I actually made it as shown in **Fig. 3**. That was in the winter term of **69/70** but I probably have known Uli a bit longer by then.

From the results of that first interaction between the two of us we can already draw a few major conclusions:

1. He was just **20 years old** when he was at least in the 5th term. That means that by today's standards he was a baby when he joined the university. Not only had he obtained his Abitur (high school diploma) in 1967 being just 18 years old, he also avoided being drafted by the Army (I wonder how). We might conclude that **he was always smart** – finishing High School early and somehow circumventing the army bears witness to this.
2. He was **theoretically inclined**. He could do Quantum Theory while I (and many others) had problems with that. It follows:
3. He was (and still is) **smarter than I,** if not smarter than most of us.
4. Most remarkable, however: **He was generous** and shared his achievements with the his more dimwitted fellow students. Our only consolation was that we dimwits held a comfortable majority.

Many of us in those days also went to non-science lectures on occasion. God knows why. Out of a sense of duty maybe, or more likely in the hope of meeting girls. Uli and I went to a whole lecture course about **Mozart**. The Professor once delved into Mozart's travel to Prague, a famous event in 1787 that actually triggered a novel[4)], and asked his students why Mozart was so excited and really looked forward to the premier of his "Don Giovanni" there? Uli volunteered an answer: "because they offered him a lot of money?". The Professor was aghast! While Uli's answer was perfectly logical and possibly even true, it certainly did not confirm to the existing dogma, which was that Mozart liked the Prague people because they received him very warmly before and understood his music.

This little anecdote proves theorem No. 5:

5. His **capability of making snotty but irrefutable remarks** that sends the audience gasping was already highly developed early on.

This interesting character trait was recognized early on by his colleagues in the MPI; **Fig. 4** shows the evidence[5)].



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108

H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

Two years ago, to give a more recent example, he stupefied his august advisory board when he announced in public that his goals for the future were to cut down third party funding and publications by 60% or 30 %, respectively.

How did he get in? Into the **MPI for Metal Physics**, I mean. Well, like many others including me, Prof. Seeger, the King of the MPI for Metal Research, and his cronies, e.g. Prof. Frank or Prof. Kronmüller, snared him. As is the custom of the MPI's to this very day, they trapped unsuspecting but promising students they got to know from giving lecture courses at the nearby university, by promising them untold riches, free beer, and scantily clad women. That's at least how we university professors think it's done.


***Fig. 4*** *Master of pointed remarks.*

As it happened, we went for far less: just the opportunity to do one's diploma thesis at the famous and rich MPI. Uli and I started scientific work at the MPI around 1972/73; Uli in theory, I myself in electron microscopy. It ended for both of us in a long-lasting friendship, a Diploma in Physics and eventually a doctorate coming with a German style Doctor hat. I will come to that.

## 3. Scattering Events

If we now consider the **major scattering centers** we must start with the females of the species. There would be much to say about Uli Gösele's average **scattering length** with respect to the typical female scattering centers in the halcyon days of the mid-seventies, or the **time constants** going with that. I will, however, not go into this in any detail except for stating that mostly he remained close to equilibrium, flitting from hither to thither but not going very far. The equipartition theorem was obeyed and I was envious. Very envious.

Uli had a way with girls, excuse me women, that many of us experimentalists including me could not easily emulate. In particular, he could motivate them to do what **he** wanted **and** feel good about that. This illustrates the next point:

6. **Uli Gösele is a motivator**. He is supremely efficient in motivating people to do science and other things; and he was good at that quite early.

But one special day or possibly night he didn't just get scattered around while kind of staying in place on average, interacting only weakly, but got actually **trapped** fairly



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*
Journal of Crystal Growth 40 (1977) 90–108

Received 19 January 1977

and squarely by **Julia** (**Fig. 5**), his longtime playmate (and I mean this in the sense of having sat in a sandbox together as toddlers, probably playing doctor).

***Fig. 5*** *Mrs. Julia Gösele*

However, on second thoughts, there is a suspicion that this particular trapping might have been square but not entirely fair.

Whatever, he bumped or bumped into Julia in an irreversible way that lead to a sudden increase of the generation rate and caused major deviations from equilibrium: Julia became pregnant in **1974**, in the midst of this PhD work, and his daughter **Andrea**, was born in **1975**. Before that, the couple duly married on **October 11th, 1974**, of course. Those were the God-fearing good old days after all. While Julia's father did not own a shotgun, he was a minister and could be expected to be able to either raise hell or the wrath of God (same thing probably).

Uli obtained his doctorate degree in July 1975 being 26 years old, married, and with child. Needless to say, he was ahead of me by one year with respect to the doctorate. With respect to the rest he beat me by 6 and 11 years, respectively. **Fig. 6** gives some impressions of this event and illustrates the famous German "Doktorhut", always coming with the best things inside.

**Weiterentwicklung der Theorie diffusionsbestimmter, bimolekularer Reaktionen mit Anwendungen**

vorgelegt von
**Ulrich Michael Gösele**
geboren in Stuttgart

| | |
|---|---|
| Hauptberichter: | Prof. Dr. A. Seeger |
| Mitberichter: | Prof. Dr. H. Kronmüller |
| Tag der Einreichung: | 20. Mai 1975 |
| Tag der mündlichen Prüfung: | 10. Juli 1975 |

***Fig. 6a)*** *PhD Thesis*



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977


***Fig. 6b)*** *Doktor Uli Gösele. Note the weak scattering center on the right (Old groupie; Psychology student).*


***Fig. 6c)*** *What's inside?*



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

***Fig. 6d)*** *Werner Wasserbäch and Your's Truly. Note that in those days the men wore the long hair, quite often all over.*



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

On his Doctor hat we read: *Psi hilft: Krautіon entdeckt* (Psi helps: cabbage-ion discovered), a word play on "crowdions", and this sentence conveys a lot of meaning to the cognoscenti:

- Uli, like me and most everybody else in physics, was interested in "**PSI**", psychic power, which was very popular in those long bygone days. We were interested in putting whatever there was on a solid physics base. Uli even considered joining the "Institute for Parapsychology" of the University of Freiburg, run by the then rather famous Prof. Bender. Those were the days, my friends, when we had dreams of opening new fields in physics and aspired to understanding the universe at large, not to mention the female mind. Today, being older and possibly wiser, we settle for understanding the difference between a Trollinger and a Lemberger.
  In the end he did not join that outfit. An action like that would have constituted a momentous **scattering event** that would have kicked him on some imaginary plane from where no return to serious science would have been possible.
  We have a near miss here and as outlined above this teaches us a lesson: Like with wave functions, there is a certain probability that you get very close to a major scattering center but nothing happens. These almost-but-not-quite scattering events, let's call them **non-scattering events**, also shape ones destiny and some must be considered here.
- The sentence expresses some doubts that the existence of the **crowdion** has been well established, and asserts that this might only come about by resorting to the paranormal. That was an attitude that Uli increasingly shared but could not afford to voice too loudly. In a letter to me from Dec. 21st, 1976 he wrote: "*Physikalisch läuft es bei mir, dank der unvermeidlichen Beschäftigung mit dieser schwäbischen ZGA Spezialität, ziemlich schlecht*" (In Physics it's not going well thanks to the unavoidable work with this Suebian interstitial specialty).
- The "*Kraut*" = cabbage refers to the fact that Uli lived in the major sauerkraut growing area of Germany. Just as sauerkraut is not the ultimate in high cuisine but rather a local abomination, the quip intimates that the Krautіon might not be the ultimate in science either.

The next picture (**Fig. 7**), shows my doctor-hat party on **May 13th 1976**. **Andrea Gösele**, held by Mommy, looks a bit skeptical about my achievements while her father nevertheless congratulates me.

Having a family was tough, or in the words of Uli (Oct. 25th 1977): "*Mit einem Kind ist es übrigens sehr schwierig, vielen Interessen nachzugehen, alldieweil man sehr angebunden ist und wenig Zeit hat*". (By the way, having a child makes it very difficult to follow many interests because one is tied down and has no time). How true!

Pursuing his career, Uli Gösele had a certain disadvantage in comparison to me. His father was a fairly well known Professor of Acoustics and deep down Uli felt that he had to emulate him by also becoming a famous Professor one day as a matter of



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*
Journal of Crystal Growth 40 (1977) 90–108

Received 19 January 1977

course. In comparison, my father's only claim to fame was that he once owned a horse that liked to drink beer and eat ham. I could easily outperform that horse at age 16 and anything beyond that was already counted as a career success. By being admitted to the university I had already met all expectations, mine included, and could afford not to understand quantum mechanics without suffering ego problems, while poor Uli had to be good in quantum mechanics and everything else.

***Fig. 7*** *Uli congratulates me; Andrea is watching.*

I'm just joking, of course. My parents worked hard to put me through high school and university and I did feel some pressure. However, the idea of becoming a Professor one day in the distant future did never ever occur to me even in my wildest dreams around this time.

Getting back to the happy or at least young family: Julia had not quite finished her study courses for High School Teaching (History and English) before she gave birth, and some thesis work was missing. But now she was not only stuck with an infant, but also with the proper care and maintenance of a budding scientist and didn't quite feel up to topics like: "*Generative Transformationsgrammatik im Mittelenglischen*" ("Generative transformation grammar in middle English"; whatever that might mean).

Uli insisted that she should nevertheless get her degree, and the solution found was that he helped with writing the papers. In a letter to me he only complained that this was time consuming but not that it was difficult. I won't go into details because there might be legal issues involved but knowing what I will diplomatically call the scientific culture of pedagogy, it is safe to say that this proves what many of us have always suspected:

**7.** If needs be, **Uli Gösele is a prime bullshit artist;** at least as good as you and me.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*
Journal of Crystal Growth 40 (1977) 90–108

Received 19 January 1977

We will now move on to another major scattering event that happened in **1976**: Uli Gösele bumped **into** me. Looking at the relative masses for this particular collision it is clear that this changed his course of direction far more than mine. I mean Uli was and is slim like a $\mathbf{FeSi_2}$ precipitate, while I always had a tendency to optimize the volume to surface ratio.

In other words: Uli is anisotropic. Rub him in the easy direction – and you get very positive results. Rub him in the hard direction – and you get into trouble. It is mildly interesting to note that people who are most familiar with that phenomenon, for example people working on magnetism, had sometimes problems in optimizing this rubbicity problem and then may have faced some degree of diabolicity[6].

But back to Uli being scattered at me. What happened was that I tried to understand the formation of interstitial agglomerates in Silicon - so-called swirl defects - and that took some theory that I still couldn't do myself. You actually needed a computer; one of those big things in a building of their own, with more than 100 kB of memory, to which you lugged heavy containers full of punch cards. So I had no choice but to motivate or bully Uli to start working on **point defects and diffusion in Silicon**, something that was actually frowned upon at the MPI. I was successful, and I do believe that somebody out there owes me a beer or two for that major advancement of semiconductor science.


***Fig. 8*** *Where we hiked and got lost.*



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

The two of us were good together, if a bit stupid. We actually invented **nucleation theory** and so-called **TTT-diagrams** all by ourselves instead of reading it up in some textbook. Anyway, the resulting paper (including **Bernd Kolbesen** from Siemens, who not only supplied the Si and many experimental data but also the voice of reason) and later work that Uli did himself was instrumental in establishing the **self-interstitial** as a major point defect in Silicon. Of course the new paradigm didn't go down uncontested by the establishment, and we had many interesting discourses with referees. Uli complained about that quite a bit in many letters to me.

The two of us were rather close by then and went on a lot of hikes in the "**Schönbuch**" forest, close to where the Gösele's lived (**Fig. 8**). The objective was to discuss God and the world, the unfathomable machinations of females, and to get lost by practicing random walk. I had a bit of a crisis then (correlated to the unfathomable machinations of females) and Uli gave me sage advice: "**Write it all down**", he said, "and keep it so that in twenty years from now you have something to laugh at".

I not only followed his sage advice but also generalized it by keeping everything else I had written down **and** the responses - and that means that I still have **all the letters** we exchanged. Uli now has some trepidations because he doesn't know any more what he wrote and might be open to blackmail. Well, before I embarrass him further him with some more quotes, I like to draw conclusion No. 8:

**8.** Uli Gösele is a **great friend** and one should always **heed his advice**.

The next major scattering event kicked him to South Africa and resulted from a horrible **aircraft crash** on November 20th, 1974. The Lufthansa 747-100 starting in Nairobi, Kenya, was not properly configured for takeoff and stalled shortly after becoming airborne, crashing about 3600 feet (1100 meters) beyond the end of the runway (**Fig. 9**). The crash killed 55 of the 140 passengers and 4 of the 17 crew. One of the people killed was Prof. **Isebeck** from the South African Atomic Energy board, a close collaborator of Prof. Seeger.


***Fig. 9*** *Boeing crash*

Prof. Isebeck's group was left without a leader and Seeger simply ordered Uli Gösele to go down south and take over for a year. Julia, like all of us, took a very dim view of South Africa, what with apartheid and all that, and didn't want to go. After a few months she didn't want to come back. Sympathizing with the benighted and exploited Blacks down yonder from afar was one thing, living in relative luxury because even a modest apartment came with servants, is another thing. She wrote me long letters (that I still have),



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*
Journal of Crystal Growth 40 (1977) 90–108

Received 19 January 1977

rationalizing about her conversion just as cleverly as I rationalize now about the need of driving a fast convertible after turning 60 years old.

Andrea, not quite one year old, didn't like to go there either. She was yelling at full throttle for many hours of flight. As Uli put it: "*Andrea war eine ungern gehörte Alleinunterhalterin*" (Andrea was an unpopular solo entertainer). Finally her father gave her some beer to drink. Being a German girl she imbibed it without hesitation and slept happily ever after. That proves theorem No. 9:

**9.** Uli Gösele, when facing tough problems, comes up with **unconventional solutions** that actually work but may **not always find the approval of the timid**.

We exchanged an unbelievable amount of letters while he was in South Africa. Here are a few interesting quotes:

**Oct. 76**: "*Entschuldige bitte, dass ich private Dinge auf einen separaten Brief verschiebe, nicht nur weil das AEB offensichtlich alle Briefe photokopiert und zu den Akten legt, sondern weil ich morgen früh wieder kurz nach 6 Uhr aufstehen muss* ***und mein Bier ausgeht***". (Please excuse that I send private things in a separate letter, not only because the AEB obviously copies all letters and files them, but because I have to get up tomorrow morning early shortly after 6 a.m. and **my beer supply runs out**).

This allows to deduce another character trait:

**10.** He always knew what his **priorities** were.

**Oct. 76** "*Am Atomic Energy Board läuft alles gut, wenn man davon absieht, dass die Sicherheitsleute meine Art von Humor nicht verstehen*". (Everything goes well at the Atomic Energy Board except the guards don't understand my kind of humor).

Oh yes! We understand. As we know now, these guys were secretly trying to build the bomb in those days, and the security personnel sure like hell was not particular to Uli's brand of dry humor. They, like some other people I could name, would still not understand it today.

In **Oct. 1977** he came back to the MPI in Stuttgart. What we have here is once more a **non-scattering event** – he would much rather have obtained a good position somewhere else but somehow missed to run into the right scattering centers. It was back to the Crowdion; semiconductors were still frowned upon or even expressively forbidden. I wasn't there anymore but from many letters we exchanged it is clear that it was not a very happy time. On the bright side he received the **Otto-Hahn medal** and that came with some money for a sabbatical abroad. On the not-so-bright side, his boss absolutely refused to let him go for quite some time.

**Fig. 10** shows a particular interesting quote from a **Nov. 78** letter:

There are interesting points about that sentence. First, the "**about**" expresses the remoteness of retirement as seen from the year 1978. Projecting to age 60 or 65 - that's about the same from the viewpoint of 30 years old. Of course, when you're actually 60

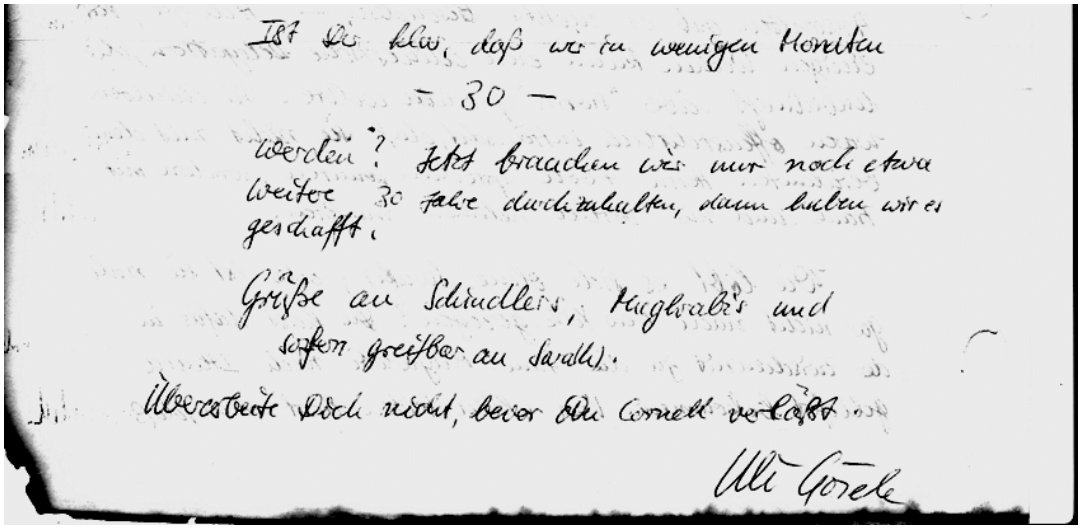


THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

years old some 30 years later, and the Max Planck Society suddenly raises the retirement age to 67, this looks quite different.




*Ist Dir klar, daß wir in wenigen Monaten – 30 – werden? Jetzt brauchen wir nur noch etwa weitere 30 Jahre durchzuhalten, dann haben wir es geschafft.*

(Do you understand that we will turn 30 years old in a few month? We now need only to persevere for about another 30 years, then we will have made it).

***Fig. 10*** *Uli is looking ahead.*

Second**,** what does the "**made it**" mean? I could probably tell you but will just state that he certainly "made it", indeed. I "made it" too, I believe, but in a somewhat different way. Anyway, what we conclude is:

**11. Uli Gösele always looked ahead** and does long-term planning.

Now we will have to look at another major **non-scattering event** that did not take place in May 79. Uli Gösele was so desperate and fed up with chasing crowdions that he applied for a "Professorship" at the Fachhochschule Stuttgart (a technical junior school without research, just teaching) based on his acoustics background coming from a few projects he did with his father; see **Fig. 11**. He **almost** made it – he was number two on the list. Luckily, number one accepted and Uli was saved for serious science.

There is a message here for budding young scientists: Sometimes a major disappointment experienced now may turn out to have been good for you later in life!



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

Im März habe ich mich mit Riesenaufwand + Vortrag etc um eine "Professur" an der Fachhochschule hier beworben. Ich stehe auf Platz zwei und Nummer eins hat zugesagt. Mein Thema war "Schallschutz gegen Außenlärm"; ich habe einiges über Mauern, Rolladenkästen, Fugen, Schlitze, Kastenfenster und Verbundglasfenster sowie Verkehrslärm dazugelernt.

*Im März habe ich mich mit Riesenaufwand + Vortrag etc. um eine „Professur" an der Fachhochschule hier beworben. Ich stehe auf Platz 2 und Nr. 1 hat zugesagt. Mein Thema war „Schallschutz gegen Außenlärm"; ich habe einiges über Mauern, Rolladenkästen, Fugen, Schlitze, Kastenfenster und Verbundglasfenster sowie Verkehrslärm dazugelernt.*

In March I applied with tremendous effort + presentation for a "professorship" at the technical School here. I'm on second place and number one accepted. My topic was "Acoustic protection against external noise"; I did learn quite a bit about walls, shutters, containers, ….

***Fig. 11*** *Momentous non-scattering event in 1979*

We will now move on to the next major scattering event. You may not believe it, but the Gösele's bumped into me again. I was just finishing my year and a half as a post doc at the **IBM** Yorktown Heights laboratories, working for **Paul Ho** and **King Ning Tu**, when Uli, after much ado with his Boss Alfred Seeger, joined exactly that outfit. The Gösele's came at the precise moment when I was leaving. They actually took over my apartment and my car, complaining bitterly and correctly in some letters that she (the car) was a lemon.

Here is a quote from a letter of mine from Oct. 11th 1980: "*Es tut mir leid, dass Ihr Ärger mit dem VW Bus hattet, obwohl es mir viel lieber ist Ihr hattet den Ärger und nicht ich*" (I'm sorry that you had some trouble with the VW Bus, although I much prefer that you had the trouble and not I).

That probably proves something about me but fortunately that's not the topic here.

Like before, I dragged Uli into my research topics and he actually made some sense out of my experimental findings. He explained, as I believe for the first time, why in reactions of Silicon and some thin film of a metal you didn't find all the silicide phases predicted by the phase diagram.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

More important perhaps, I introduced him to **Teh Yu Tan** who dwelled in some remote corner in the IBM basement. Teh Tan was a true scattering center that changed Uli's scientific direction for good. I was and am very fond of Teh Tan because he is not only a great scientist but also a decent human being. He took pity at me when I had been at IBM research for more than 4 or 5 months and did not yet have a publication to my name. He made me the co-author of some of his publications even though I had only a rather minor claim to this honor. I like to believe that I didn't let him down in the end – from my year and a half at IBM a grand total of 17 publications resulted, 10 with Teh Tan as co-author.

Uli and Teh Tan hit it of wonderfully and wrote more than 125 publications together. While it cannot be proved that Uli wouldn't have run into Teh Tan without my prodding, I nevertheless believe that someone out there owes me another beer or two for once more enriching Semiconductor research.


***Fig. 12*** *Goodbye party for the Föll's in 1980.*

While I left IBM for Siemens in 1980 – **Fig. 12** shows a picture of the farewell party - Uli grudgingly went back to the MPI in Stuttgart in July 1981, commencing work on the Kraution once more, and also attempting a "**Habilitation**". There were some weird scattering events in this process, very non-elastic and non-linear and with plenty of energy dissipation, but Uli muddled through with determination and stamina[7]. Uli also voiced increasing doubts at some particular interpretations of point defects in metals that had been canonized in Stuttgart, and that got him into increasing trouble. When he was ordered again to stop any work on semiconductors[8)], he eventually took an offer from Siemens and moved down to Munich in Sept **1984** – sans (by now increased[9)]) family. One could say that he was scattered either from one-dimensional crowdions or from a kind of one-dimensional philosophy of how to do science.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

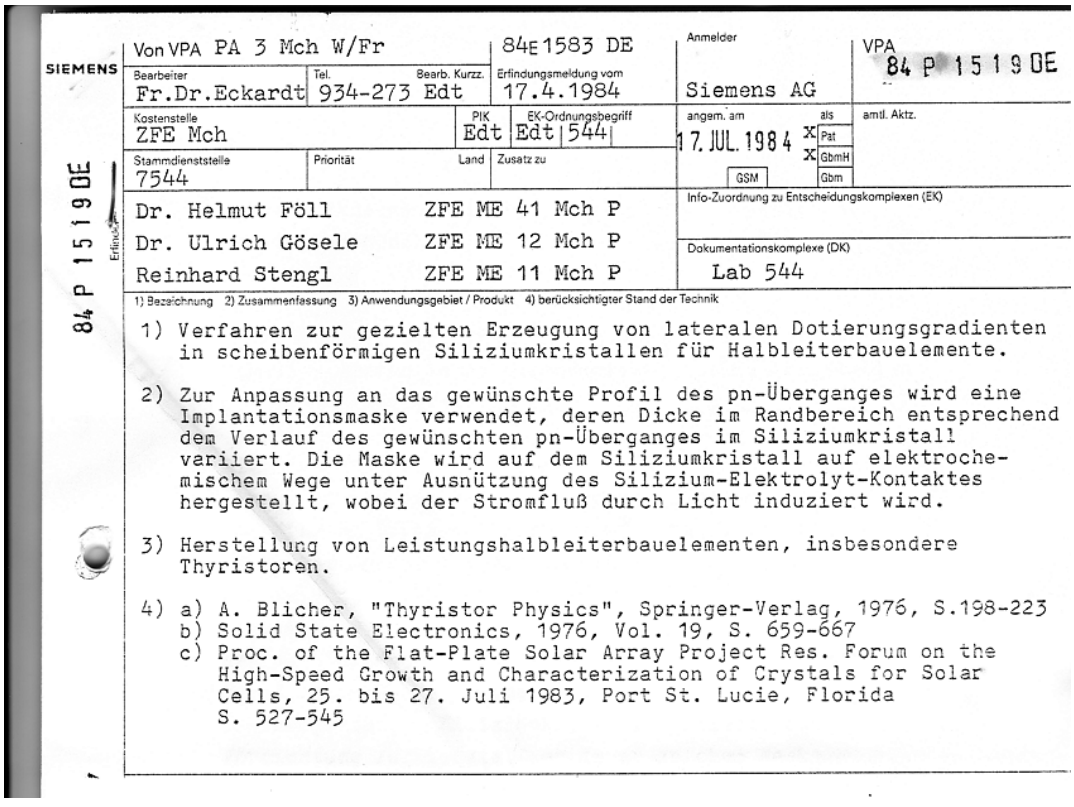
H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

I mention this for the sake of the young scientists here who feel, correctly so, that it's tough to make a career in science. You see, it was already quite tough 30 years ago.

Since I had never considered myself up to the rigors of a scientific career but had joined Siemens in 1980 for a career with some money in it, we now found ourselves in close proximity once more in 1984.

Of course, Uli had no intention to stay at Siemens for very long, he wanted to become a Professor after all. However, the flirt he had started with Duke University had not yet flowered into a solid relationship and that gave us the opportunity to do interesting work together once more; we actually filed a patent together (**Fig. 13**). Unfortunately, even so it was a pretty clever patent it didn't make any money. We wouldn't have minded a bit of additional income, because Uli now had to support a family of 5 including him, and even I, to my utter amazement, had been snatched up by a Manhattanite, who married me, followed me to Munich and eventually produced offspring. Ironically, Uli was not on another patent for the so-called "ELYMAT" even so he had a small part in it. The irony lies in the fact that it is the only one of my 20+ patents that has made an extremely humble amount of money so far.



SIEMENS

Von VPA PA 3 Mch W/Fr | 84E1583 DE | Anmelder | VPA 84 P 1519 0E

Bearbeiter: Fr.Dr.Eckardt | Tel.: 934-273 | Bearb. Kurzz.: Edt | Erfindungsmeldung vom: 17.4.1984 | Siemens AG

Kostenstelle: ZFE Mch | PIK: Edt | EK-Ordnungsbegriff: Edt 544 | angem. am: 17. JUL. 1984 | als: X Pat, X GbmH, GSM, Gbm | amtl. Aktz.

Stammdienststelle: 7544 | Priorität | Land | Zusatz zu

Dr. Helmut Föll ZFE ME 41 Mch P
Dr. Ulrich Gösele ZFE ME 12 Mch P
Reinhard Stengl ZFE ME 11 Mch P

Info-Zuordnung zu Entscheidungskomplexen (EK)

Dokumentationskomplexe (DK): Lab 544

84 P 1519 0E

1) Bezeichnung 2) Zusammenfassung 3) Anwendungsgebiet / Produkt 4) berücksichtigter Stand der Technik

1) Verfahren zur gezielten Erzeugung von lateralen Dotierungsgradienten in scheibenförmigen Siliziumkristallen für Halbleiterbauelemente.

2) Zur Anpassung an das gewünschte Profil des pn-Überganges wird eine Implantationsmaske verwendet, deren Dicke im Randbereich entsprechend dem Verlauf des gewünschten pn-Überganges im Siliziumkristall variiert. Die Maske wird auf dem Siliziumkristall auf elektrochemischem Wege unter Ausnützung des Silizium-Elektrolyt-Kontaktes hergestellt, wobei der Stromfluß durch Licht induziert wird.

3) Herstellung von Leistungshalbleiterbauelementen, insbesondere Thyristoren.

4) a) A. Blicher, "Thyristor Physics", Springer-Verlag, 1976, S.198-223
b) Solid State Electronics, 1976, Vol. 19, S. 659-667
c) Proc. of the Flat-Plate Solar Array Project Res. Forum on the High-Speed Growth and Characterization of Crystals for Solar Cells, 25. bis 27. Juli 1983, Port St. Lucie, Florida S. 527-545

***Fig. 13*** *Our common patent*



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

The next major scattering center that changed Uli's scientific life was a piece of art in my house (**Fig. 14**). Uli was intrigued; inquiring about it he got to know the artist, **Volker Lehmann**, who had been in my outfit at Siemens for quite a while.

**Fig. 14** *"Goethe und die Theoretische Elektrotechnik"*[10]
*(Goethe and the theory of electrical engineering)*
*by Volker Lehmann, 1983.*
*80 cm x 80 cm; metal foil from the tops of wine bottles over wood relief.*



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

Volker had started at Siemens as a student intern and then worked his way up to a PhD degree via a diploma thesis, with all of the practical work done in the Siemens laboratories of my group. Volker and I had discovered how to make those macropores in Si and lots of other strange stuff related to the electrochemistry of semiconductors, a topic that was destined to play a major role in Uli's future research.

After Uli left Siemens in Oct. **1985** for a full **Professorship at Duke**, he convinced Volker to join him as a post doc in **1989**. Together they wrote the seminal paper: "Porous Silicon formation: A quantum wire effect". However, the referees didn't like it at first and there is quite a story around that (**Fig. 15**).

**Porous silicon formation: A quantum wire effect**

V. Lehmann and U. Gösele

*School of Engineering, Duke University, Durham, North Carolina 27706*

(Received 13 March 1990; accepted for publication 25 November 1990)

4. A manuscript may be accepted for quick publication (a) if it is especially important or timely; or (b) if it is likely to stimulate further work promptly or forestall needless duplication in a rapidly developing field. Indicate your recommendation by putting an "X" at the appropriate place on the line below.

Strongly oppose quick publication — Neutral — Strongly recommend quick publication

No Yes

5. If you recommend against quick publication, should the manuscript be transferred to the Journal of Applied Physics? . . . . . ☒ ☐

If yes, transfer (As is . . . . . ☐

(With revision optional . . . . . ☐

(With revision required . . . . . ☐

6. If neither Applied Physics Letters nor the Journal of Applied Physics is appropriate, can you suggest a journal which is? None!

***Fig. 15*** *Famous publication and infamous referee report*

Again, I mention this as a lesson to the young scientists. While Uli Gösele may appear to loom larger than live to a freshly minted researcher pursuing his PhD thesis, he also had to fight long and hard for having his results accepted - just as the rest of us. In fact, in many of the letters from the late seventies, we discuss the abominations of stupid referees.

Having that paper rejected hurt! Especially because a rather similar paper of **Canham** that was submitted somewhat later to the same journal was published right away.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

However, what hurt far more was that the **patent** going with it was contested by one of her British Majesty's outfits. While Uli's moral position was superior to that of the Queen, she had far more money and he finally had to sell the patent to her henchmen for ten $! And he had put such high hopes on that patent as evidenced in **Fig. 16**. It sure like hell did not pay off but the whole thing probably built character.

U. Gösele

P.S.: Wir haben gerade das erste Patent für poröses Si für aktive Halbleiteranwendungen bekommen. Ich hoffe der Aufwand hat sich gelohnt.

*P.S.: Wir haben gerade das erste Patent für poröses Si für aktive Halbleiter bekommen. Ich hoffe der Aufwand hat sich gelohnt*

(We just got the first patent on porous Si for active semiconductors. I hope that the effort will pay off.)

***Fig. 16*** *The porous Si patent (Letter from Nov. 3rd,* ***1992****)*

In 1990 I had left Siemens and became a Professor at Kiel University; fortunately they never checked my quantum theory background. Of course you cannot become a Professor without assessment letters from important people and Uli Gösele at Duke was asked to write a recommendation for me. That was a good choice because when we were young and less experienced, I always believed that I simply was not smart enough to become a Professor (there are people who believe this to this very day), and I never had any aspirations that way. It was Uli who put me right by pointing out that I compared myself to the heroes of Physics like Einstein or Heisenberg, and yes, I was not up to those standards. You should compare yourself to – he gave some professorial names that I will not disclose here - and then you don't look so bad, he advised. It was just right and proper that he now had to convince others that I would make an OK professor.

Since I did get the professorship some of you may now come up with this conclusion:

**i)** ~~**Uli Göseles's judgment is clouded on occasion**~~**.**

Hold it! You don't know what he wrote, after all – in contrast to me. The reason for this shocking breach of confidentiality is that I did not just become a Professor but at the same time the founding Dean of the new Faculty of Engineering; with full access to the archives (a cabinet in my office) of the new faculty, the headcount of which my coming to Kiel raised to 3. I will come back to that later on.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

A little later, in **1993**, Uli was offered a directorship of the MPI in Halle, followed by a professorship at the University of Halle. Guess who was asked to write a recommendation for him? There is some kind of symmetry in the universe and in our relation, it seems. Maybe we are an entangled pair? I won't disclose what I have written - but he got the positions because of or despite of that.

I was slightly ahead of him in dealing with German University bureaucracies and thus could give him some tactical advice for the negotiations. It seems that things worked out to everybody's satisfaction, with the possible exception of the bursar of the MPG who has to pay his salary.

The combination of Volker Lehmann, and me at Siemens can be seen as a multiply connected scattering center for Uli that induced the rather successful porous Silicon and later porous $Al_2O_3$ research in Halle. The last scattering event I want to relate in this context is connected to the VW Stiftung. In 1996 Uli and I had send a proposal concerning **photonic crystals** to this august funding agency; it was turned down so fast that it bordered on the insulting. This rankled Uli quite a bit and, assisted by Ralph **Wehrspohn**, he came up with the idea to start a DFG priority program for exactly this topic – Photonic Crystals. Uli, being Uli, didn't do it in the time honored way by approaching the DFG and so on, but put an advertisement in the "Physikalische Blätter", soliciting other researchers with an interest in the topic to join ranks and get going. That's remarkable enough in its own right but what makes it particularly remarkable with respect to the Göselogy I'm pursuing here, is the fact that he thought that the DFG wouldn't like a Max-Planck director to head this program, so he used my name and affiliation in the advertisement instead of his own. This too is remarkable enough just so, but what makes it **really** remarkable is that he did that **without** asking me first! I was on vacation and not available, time was pressing, and Uli made a decision; see **theorem No. 9**.

Was I pissed? No – I was not! We had a good laugh together and I admired his idea and his chutzpa. He had embarrassed me and in particular my wife far more in the past, for example when we once took him to a fancy Italian restaurant in Westchester County and he then ordered Pizza without tomatoes and cheese. What that little episode proves is simply:

**13.** Uli Gösele has a way with friends and people and is a **shrewd judge of character**.

As you have learned by now, Uli and I shared a lot: Quantum mechanics exercises, apartments, cars, letters, hikes, Teh Tan, Volker Lehmann, some research papers, a trust in each other, and almost the birthday. I could go on with depicting scattering events (and non-scattering events) but will stop her – after all he (and hopefully me) might make it to retirement age at 65 – or is it now 67 – and another paper on Göselogy might become necessary.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

## 4. The Diffusion Length

The only topic left to ponder with respect to Uli Göseles's random walk through science is his **diffusion length**. How far did he actually go in his random walk so far? He started in Stuttgart and is now in Halle, about 200 kilometers as the crow flies. It took him about 30.000 kilometers to get here – it was a random walk, true enough. But as I had pointed out before, the metric in this case doesn't call for kilometers as proper units of measurement but perhaps for the number of publications, the number of citations, or some other figures of scientific merit.

I will take the liberty to choose yet another quantity. However, before I reveal my metrics, I will base my judgment on an irrefutable authority, on Uli Gösele himself (**Fig. 17**).

After I have mentioned so many positive aspects you will certainly wonder whether there are also some weak points. The only point which comes to my mind is his increasing confidence in the correctness of his own judgement during the time of climbing the career ladder at Siemens Corporation. Based on my experience, he shares

***Fig. 17*** *From Uli's recommendation*

I will now take full advantage of my weak point as elucidated by Uli and state with the utmost **confidence in the correctness of my judgment** the following:

The most important measure of Uli Gösele's diffusion length is the **number of people he interfered with in a constructive way.**

The advisory board, to which I have the honor to belong, always praises the high spirit in Uli's group, especially among the young people; the enthusiasm for doing science, the supreme motivation for their work, the team spirit and the way they work together **and** have fun together.

Uli, you have been a major scattering center yourself for many persons, and most if not all of the many people who bounced off from you were lucky to have met and interacted with you. They came out of that encounter as better scientists if not better and happier people. I don't know exactly how many people you have helped along with their scientific career or just coping with life, but I'm certainly one of them, and for that I am grateful!

Uli, it has been a privilege and pleasure to have been your friend for many years in the past and, as I sincerely hope, for many years to come.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*
Received 19 January 1977


## Acknowledgement

The help of **Werner Wasserbäch** in retrieving pictures of the past is greatly appreciated.





THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108



H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*


Received 19 January 1977

# Uli Gösele: His Random Walk Through Science

## Pictures


**1972**; Azenbergstrasse, Room 611
with Bodmer, Dausinger, Wolf and Wasserbäch.
Beginning of the confusion period?



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

**1972**; Azenbergstrasse, Room 611
with Bodmer, Krüger and Zerweck.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

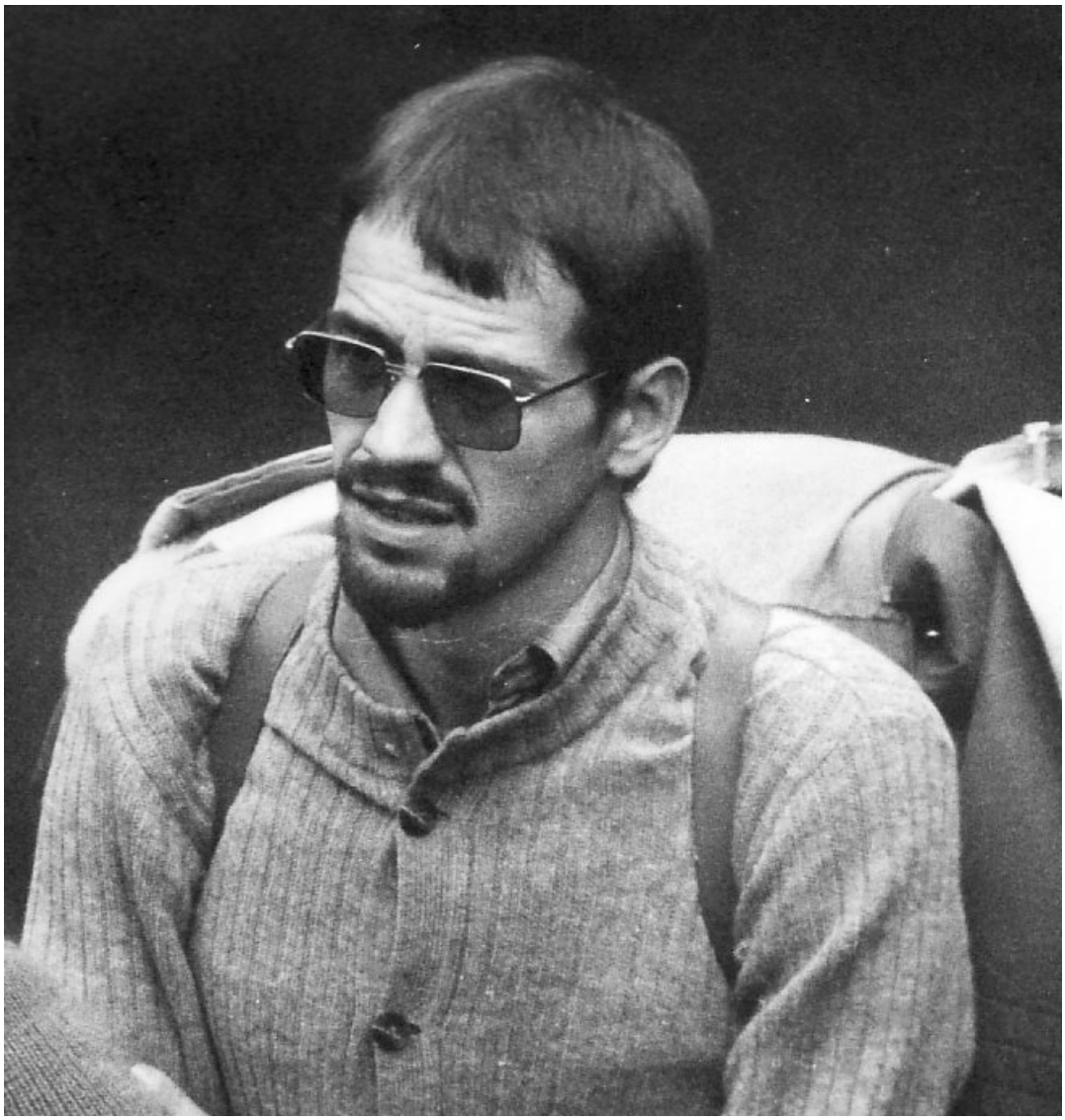

**1972**; with Lohmann and Rasch
Confusion progressing.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977



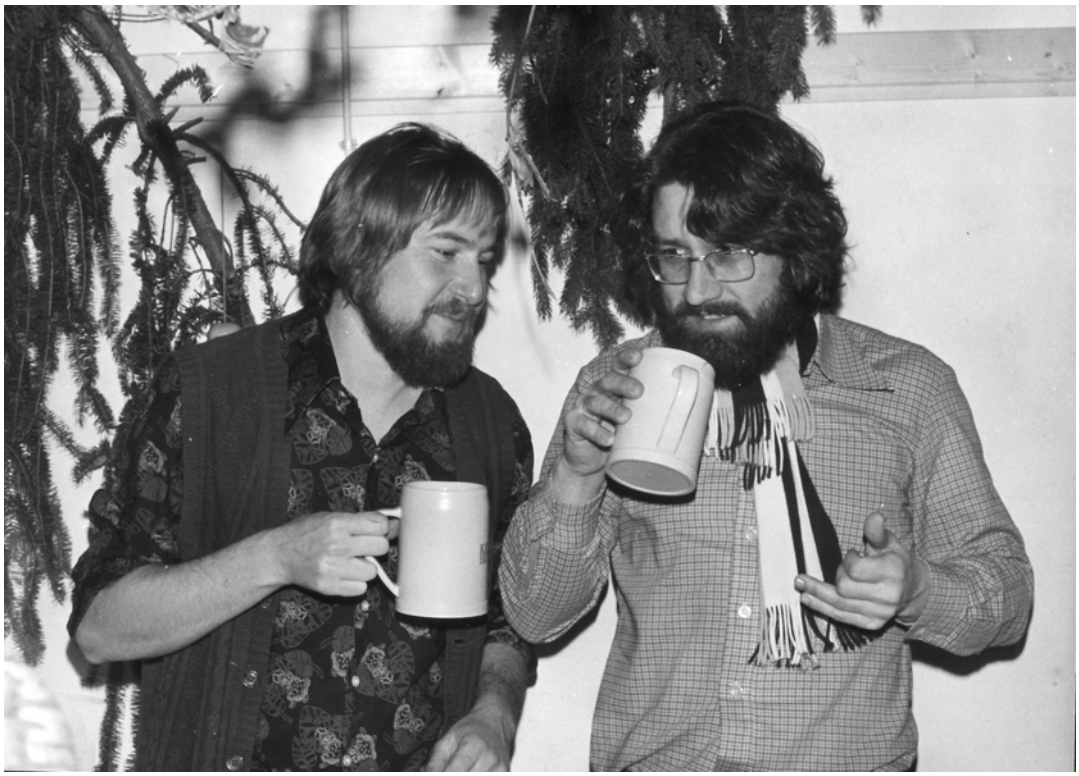
Hiking in **1974**
Looking thoughtful – freshly trapped?



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108


H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977



**1974** Zaiss and Wasserbäch. Motto: Drink beer and be merry.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

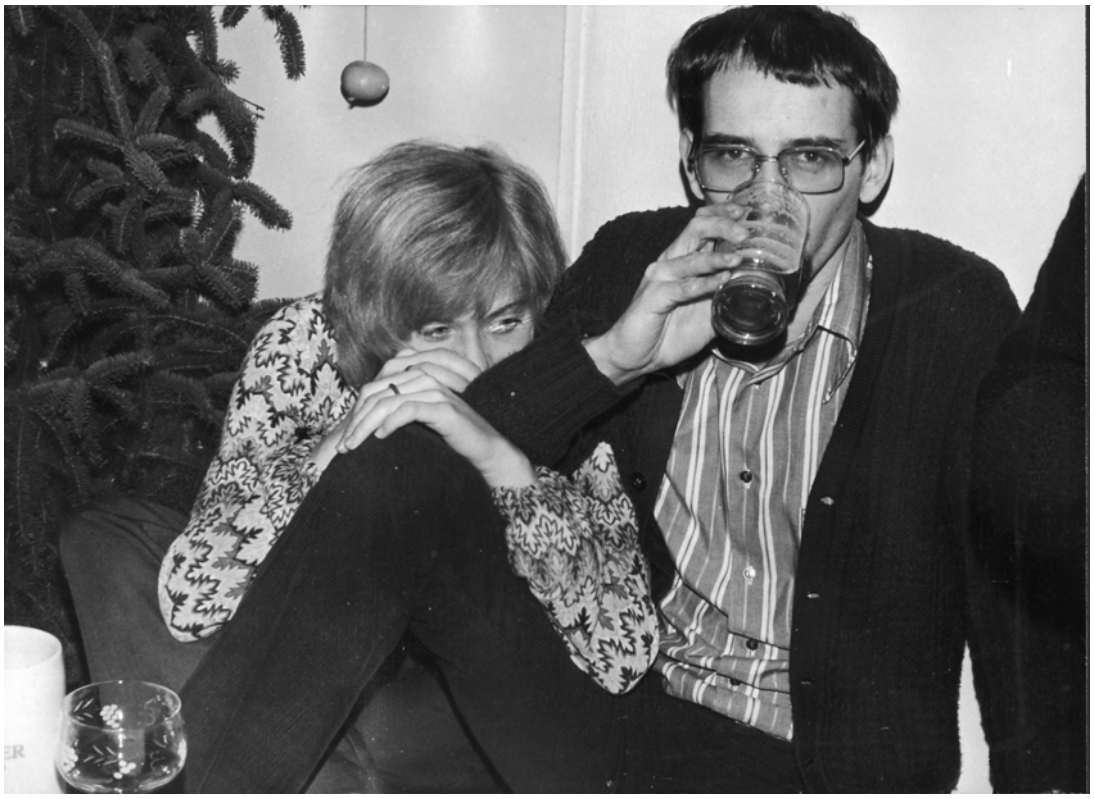
H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977



**1974** Uli and Julia. Drink beer and ~~be merry~~ marry.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

**1974/75** Weekend Hikes. Lore Holl and Regina Holz.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

**1975** Made it! - Dr. Ulrich Gösele.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

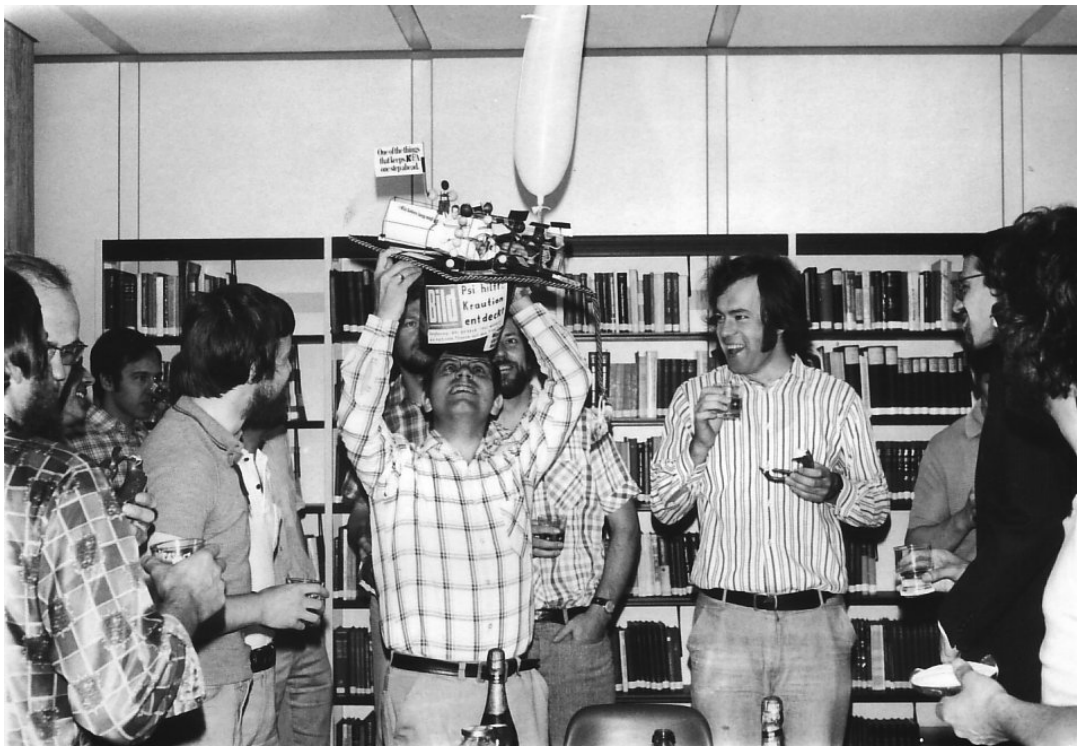

The bar is open!



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977




What's in there? Werner Frank looking.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

Aha!



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

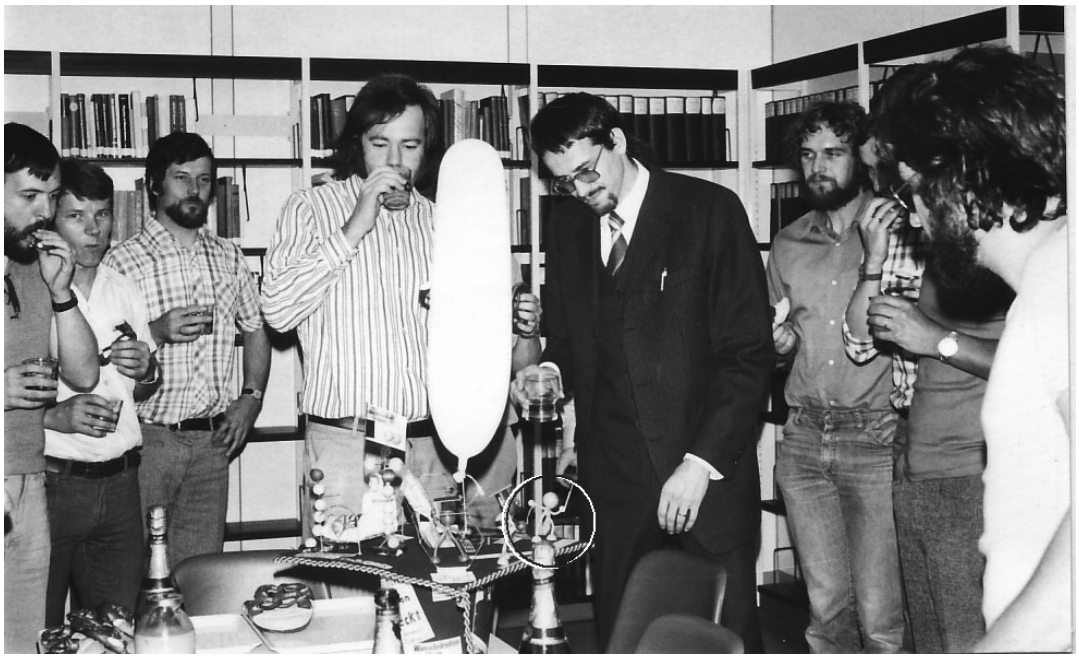
H. FÖLL * and U. GÖSELE **

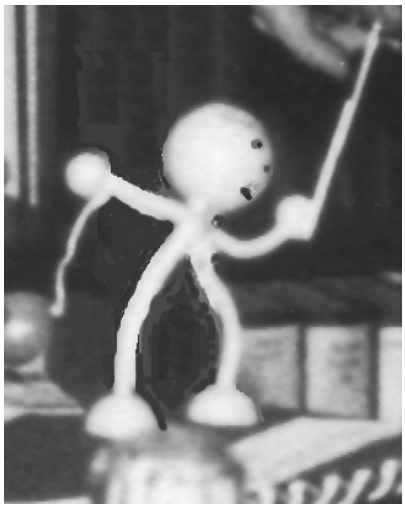
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977





Random walker on hat.

Random walker in paper

Note the details of the Dr.-hat. By psychic power the random walker appearing in the first full treatise of Göselogy has been anticipated.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

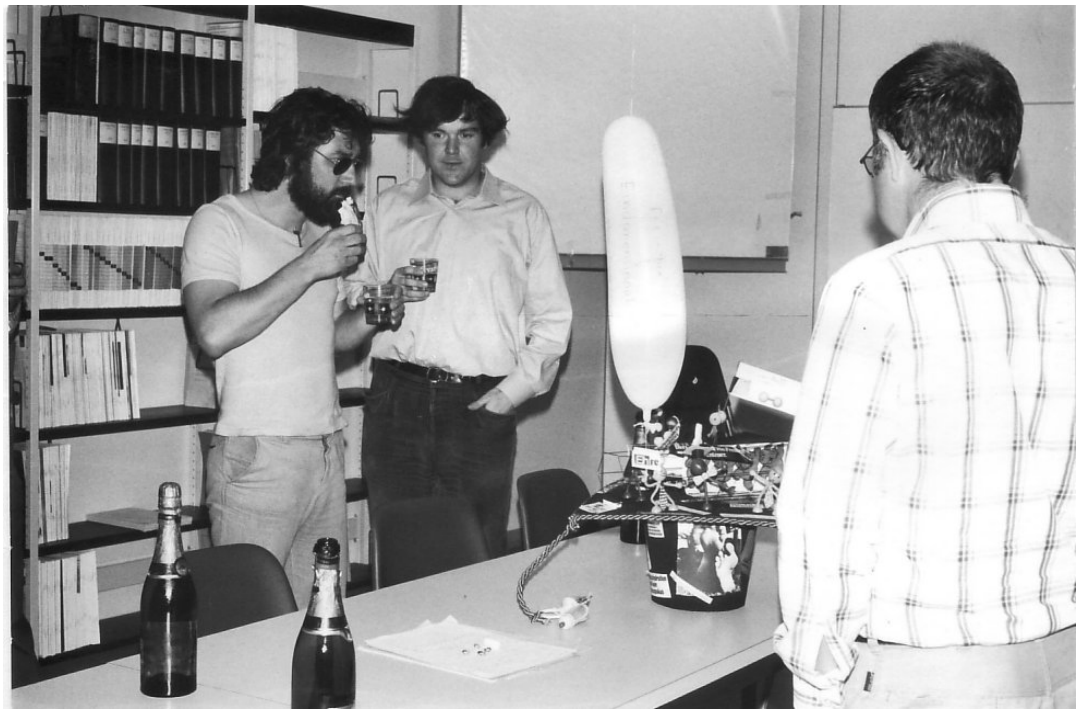

Good appetite!



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977



Wasserbäch, Föll and Frank becoming confused or inebriated



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

**1975** Mrs. Waibel and Werner Frank.



13.2

THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108

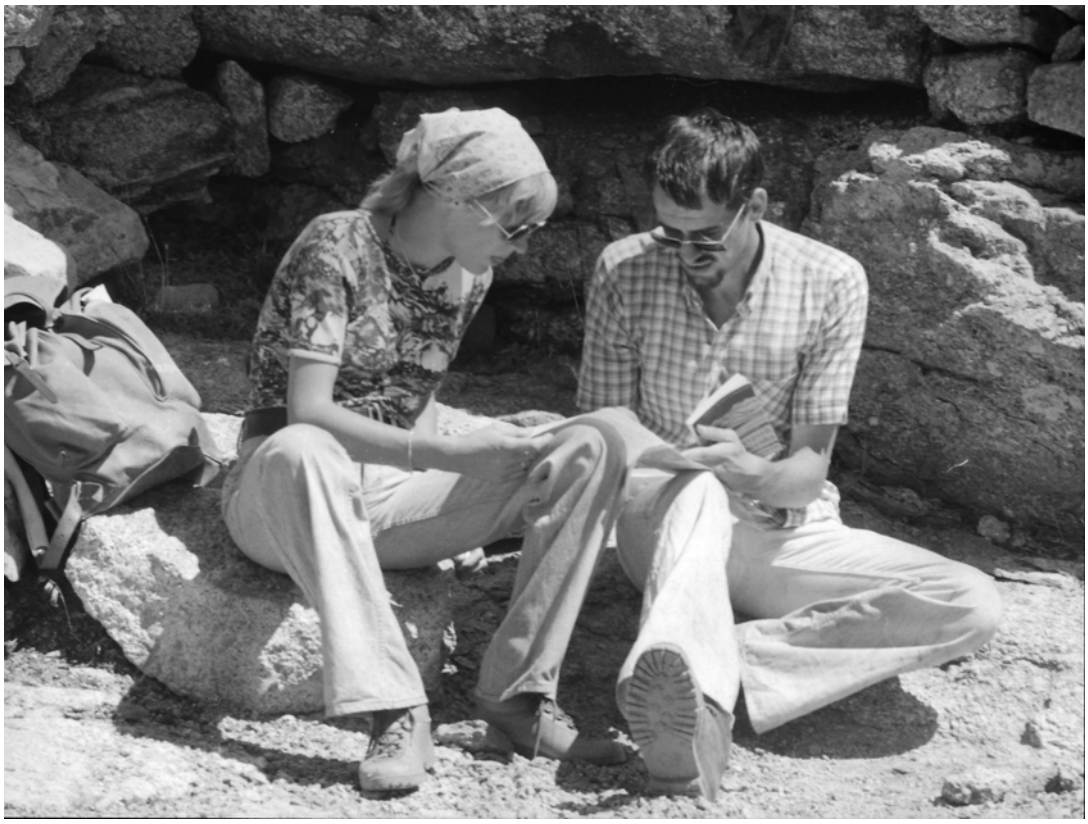

H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977



**1975** Vacation on Korsika.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

Now you feel only the normal component of the stress tensor.



13.2

THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108


H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

Seasick on the way to Florence.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108


H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977


Werner Wasserbäch's car after Helmut Föll drove it.
(Major scattering event with French 2 CV)



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108


H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977


**1975** Sports and physics (H. Föll and W. Jäger).



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

Bernd Kolbesen considers the droplet model.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108


H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977


Werner Wasserbäch about to run out of beer.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*
Received 19 January 1977

**1975** Coffe time at Fräulein Rapp.
Eßmann, Mughrabi, Schindler, Föll



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

**1976** Made it too! Dr. Helmut Föll



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108


H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

Uli congratulates; Andrea is skeptical.



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

There’s a hat in the hat!



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108


H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

Is Rapunzel in there? U. Gösele, R. Schindler, W. Jäger (covered by hat).



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

Let’s follow the swan and party! (Frl. Rapp on the right).



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108


H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977


Uli contemplating the check coming with the Max-Planck medal.



13.2

THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108


H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

**1983** On Kolbesen's "Alm" (Mountain pasture).



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

Habilitation hat?



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108


H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

**1979** Farwell party to H. Föll



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

**1980** Mount Kisco dwelling.



13.2

THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS

Journal of Crystal Growth 40 (1977) 90–108


H. FÖLL * and U. GÖSELE **

*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*

B.O. KOLBESEN

*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

**1981** Drink wine, be merry, and marry.
Sara sends her regards.

## References

1 From some festivity around 1977 at the MPI Stuttgart. The figure was drawn by Konrad Hertz.

2 Prof. Alfred Seeger; rather well rendered.

3 Check the Internet via Google.

4 Mozart auf der Reise nach Prag ist eine Künstlernovelle von Eduard Mörike, die an eine große geschichtliche Gestalt, an Wolfgang Amadeus Mozart, anknüpft und über



THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

eine völlig frei erfundene Begebenheit berichtet. Geschildert wird ein Tag aus dem Leben Mozarts im Herbst 1787.

[5] From some festivity around 1979 at the MPI Stuttgart. The quote is certainly from Uli.

[6] Check, for example: Patrick Bruno: "Berry phase, topology, and diabolicity in quantum nano-magnets" PhysRevLett.96.117208. J. Kirschner et al.: Huge magneto-crystalline anisotropy of x-ray linear dichroism observed on Co/FeMn bilayers Phys. Rev. B **75**, 224406 (2007).

[7] „Man munkelt, dass ein referee sich nicht gescheut haben soll, die Wahrheit über die Arbeit zu sagen, was nun vielleicht meine Hochschulkarriere im Keim ersticken wird". Letter from Feb. 2nd 1981.

[8] „Dabei hat mir Alfred unmissverständlich klargemacht, dass meine Halbleiterperiode endgültig zu Ende sei, wenn ich wieder in Stuttgart sei. Falls ich tatsächlich wieder Crowdionen suchen müsste, werde ich die Stellenanzeigen studieren." Letter from Mar. 30th 1981.

[9] „Übrigens A.S. (= *Arno Schmidt, unfortunately*) ist tot, siehe beiliegende Anzeige. ...Julia hat sich von einem Knaben entbinden lassen." Letter from June 7th 1979.

[10] There is a text, just read from the left to the right as usual: "Grau ist alle Theorie" (*grey are all theories*) Goethe, Faust I.



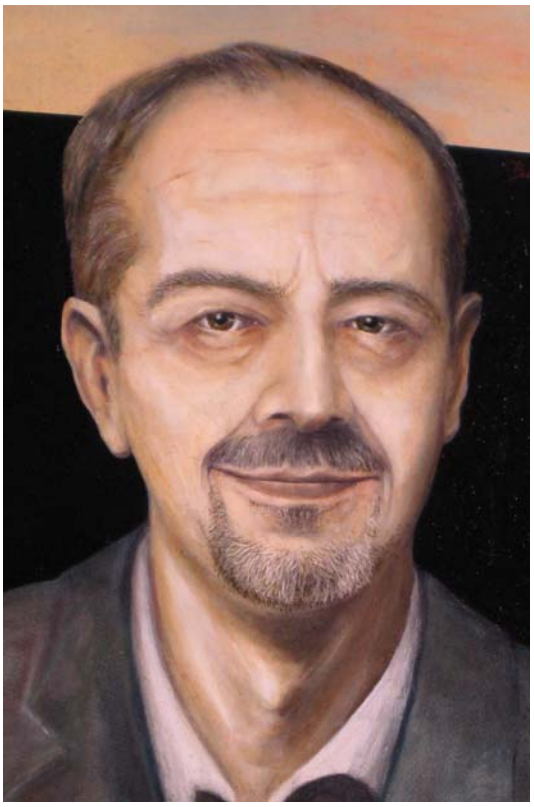
THE FORMATION OF SWIRL DEFECTS IN SILICON BY AGGLOMERATION OF SELF-INTERSTITIALS
Journal of Crystal Growth 40 (1977) 90–108
© North-Holland Publishing Company

H. FÖLL * and U. GÖSELE **
*Max-Planck-Institut für Metallforschung, Institut für Physik, Büsnauer Strasse 171, D-7000 Stuttgart 80, Germany*
B.O. KOLBESEN
*Siemens AG, Grundlagenentwicklung Halbleiter, P.O. Box 460705, D-8000 München 46, Germany*

Received 19 January 1977

# 13.6 Uli Gösele: His Random Walk Through Science

## Pictures from the Actual Event on May 15th 2009



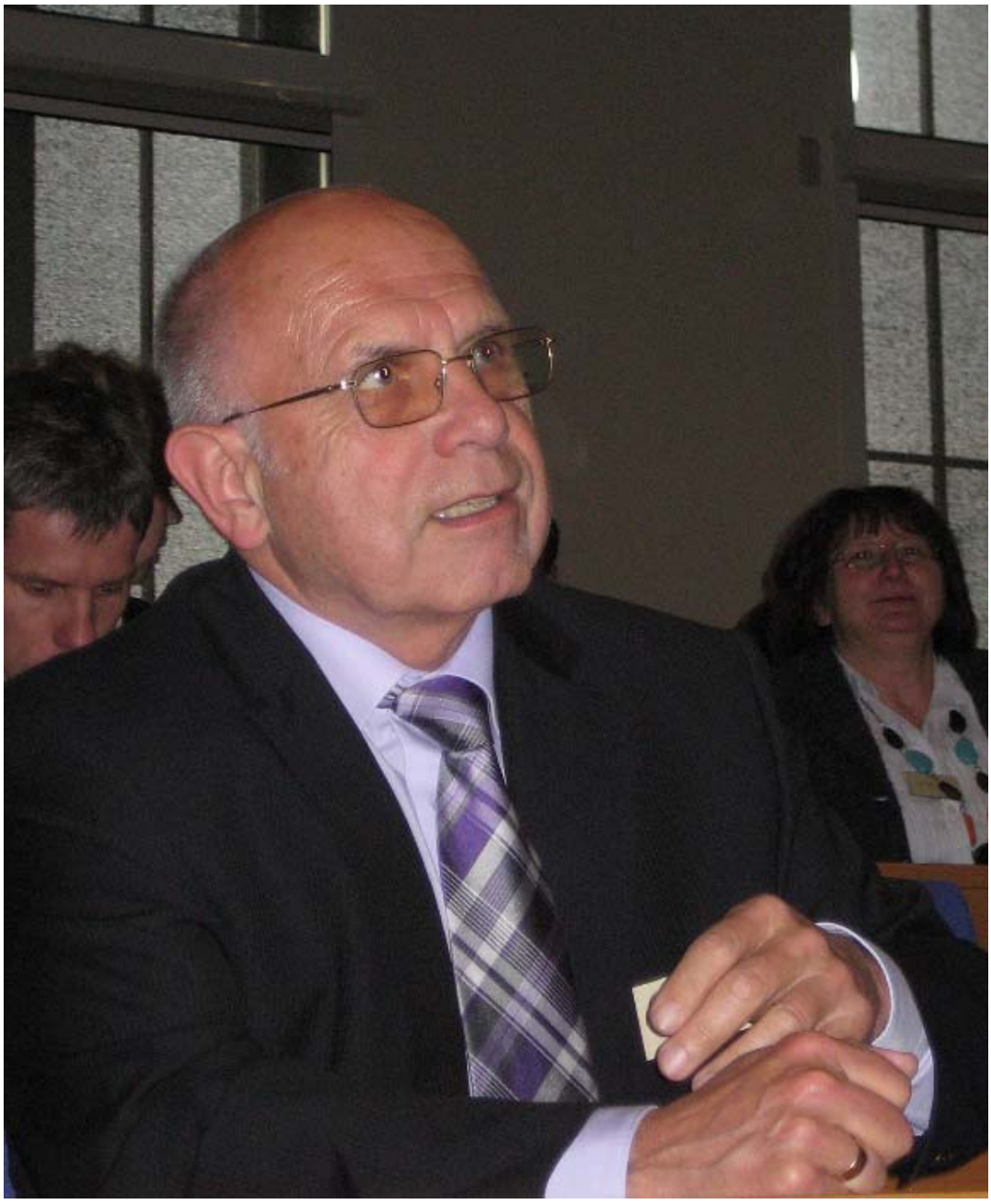
**Original** und **Portrait**

Uli obtained a portrait in oil as gift from the MPG



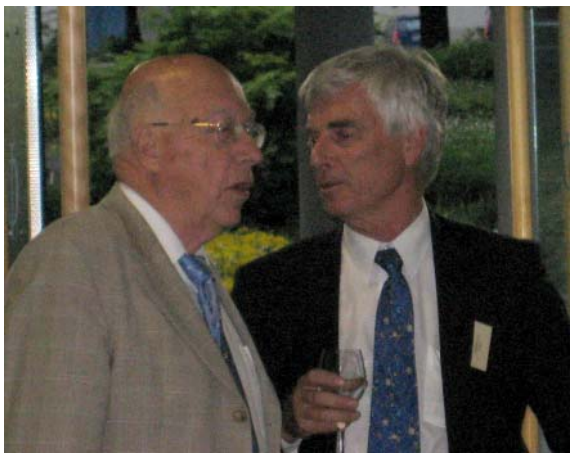
The “Festochs”. Ulf Merbold in the background

2 13.6



Prof. Werner Frank; Uli’s „Diplomvater“.





Prof. Seeger (81 years old) and Ulf Merbold




Prof. The Yu Tan

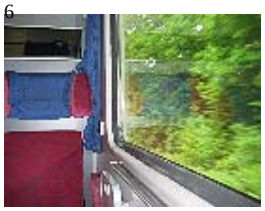


Frank Müller, Wolfgang Jäger, The Tan and Uli

Teh Tan, Uli and Prof. Heiner Ryssel



13.6

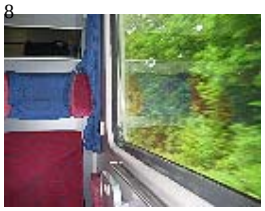


Profs. Horst Strunk and Schäfer.




Prof. Ralph Wehrspohn; the organizer.





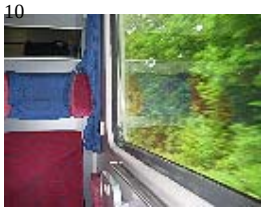
Prof. Dr. H. Ryssel proves that physicist communicate by drinking beer (or wine) and by exchanging small particles of soft matter from the body.



Judith Lehmann and Prof. Bernd Kolbesen



13.6



Uli is happy because it’s almost over



Dr. Otto Breitenstein and his team make us sing.



13.6

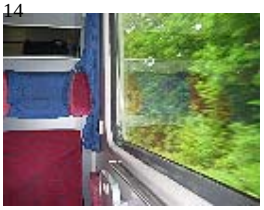

A little game involving the ladies of the institute.



Going home (McPomm and Hannover station)

13.6

14



**Lied für U. Gösele zum 60sten**

**(Mel.: Der Papst lebt herrlich in der Welt)**

1. U. G. lebt herrlich in der Welt, er lebt von unser'm Steuergeld.
Er trinkt den allerbesten Wein, drum möchte ich U. G. wohl sein.

2. Doch nein, er hat es oft nicht leicht, das Rentenalter fast erreicht
darf er noch nicht nach Hause geh'n. Dabei wär' Rentner sein so schön.

3. Er läßt auch keinen Fettnapf aus, nicht in München und nicht hier im Haus.
Er ist in's Risiko verliebt, auch wenn es manchmal Ärger gibt.

4. Ein Spitzenredner ist er auch, er halt 'nen Vortrag aus dem Bauch.
Ein jeder findet's wunderbar, auch wenn's das falsche Thema war.

5. Herr Gosele hat niemals Zeit, denn er erzählt gern lang und breit.
So'n Treffen kann schon ewig dauern, Fünf andre vor der Tür versauern.

6. Manch Slogan scheint ihm lieb zu sein: "Seeing is believing" klingt doch fein.
"There is no bad publicity", "Perception is reality".

7. G'rad darum lieben wir ihn doch und wünschen viele Jahre noch.
Heizt er uns noch 5 Jahre ein, wird es uns nie langweilig sein.

*Otto's Lied*

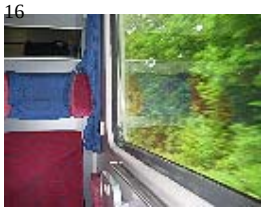


# Colloquium in honor of Professor Dr. rer. nat. Ulrich Gösele – May 15, 2009

| | |
|---|---|
| 12.00-13.00 | Arrival and light meal |
| **13.00** | **Beginning of ceremony** |
| 13.00 | Opening remarks<br>Prof. Dr. Ralf B. Wehrspohn, Fraunhofer IWM |
| | *Welcome addresses* |
| 13.10 | Prof. Dr. Jürgen Kirschner, Max Planck Institute of Microstructure Physics |
| 13.20 | Prof. Hans F. Zacher, Former President of the Max Planck Society |
| 13.30 | Dr. Valentin Gramlich,<br>State Secretary of Science and Culture, Saxony Anhalt |
| 13.40 | Prof. Dr. Wulf Diepenbrock,<br>Rector at the Martin Luther University Halle-Wittenberg |
| 13.50 | Keynote: Dr. Ulf Merbold<br>„Materials Science in Space" (held in German) |
| 14.20-15.00 | Coffee break |
| **15.00-18.15** | **Scientific Colloquium: "Random Walks through Materials Science"** |
| 15.15 | Prof. Dr. Helmut Föll<br>Faculty of Engineering, Christian Albrechts University, Kiel<br>"Uli Göseles Random Walk: Nucleation, Scattering events and Diffusion Length" |
| 15.45 | Prof. T. Y. Tan, Duke University, Durham, North Carolina, USA<br>"Diffusion and Defects in Semiconductors" |
| 16.15 | Prof. Kazumi Wada, University of Tokyo, Japan<br>"Silicon Photonics" |
| 16.45 | Coffee break |
| 17.15 | Dr. Walter Riess, IBM Research, Zürich<br>"Silicon Nanowires" |
| 17.45 | Carlos Mazuré (SOITEC)<br>"Smart Cut™ technology" |
| 18.15 | Closing remarks |
| 18.30 | Evening program at the Max Planck Institute of Microstructure Physics |



13.6



# 13.10 Nachruf (Obituary) at "Gedenkolloquium in Halle
## Long Version

Das Max-Planck-Institut für Mikrostrukturphysik lädt gemeinsam mit dem Fraunhofer-Institut für Werkstoffmechanik IWM und der Martin-Luther-Universität Halle-Wittenberg zum Gedenkkolloquium für Prof. Prof. e. h. Dr. rer. nat. habil. Ulrich M. Gösele ein.

*The Max Planck Institute of Microstructure Physics, Fraunhofer Institute for Mechanics of Materials Halle and Martin Luther University Halle-Wittenberg jointly invite to a Memorial Colloquium for Prof. Prof. e. h. Dr. rer. nat. habil. Ulrich M. Gösele.*

**Datum:** **Donnerstag, 11. März 2010**
**Ort:** **Leibniz-Institut IAMO**
Hörsaal
Theodor-Lieser-Straße 2
06120 Halle (Saale)

Organisation: Prof. Dr. Ralf B. Wehrspohn, Fraunhofer IWM

In Erinnerung an
*In remembrance of*

Prof. Ulrich M. Gösele
25.01.1949 - 08.11.2009

**Programm** / *Program*

| | |
|---|---|
| 13.00-14.00 Uhr | Anreise und Imbiss/*Arrival and diner* |
| | Grußworte/*Greetings* |
| 14.00 Uhr | Begrüßung durch Prof. Dr. Ralf B. Wehrspohn<br>Institutsleiter Fraunhofer IWM |
| | Prof. Dr. Jan-Hendrik Olbertz (angefragt)<br>Kultusminister des Landes Sachsen-Anhalt |
| | Dagmar Szabados<br>Oberbürgermeisterin Stadt Halle (Saale) |
| | Prof. Dr. Peter Gruss (angefragt)<br>Präsident Max-Planck-Gesellschaft |
| | Prof. Dr. Wulf Diepenbrock<br>Rektor der Martin-Luther-Universität Halle-Wittenberg |
| | Prof. Dr. Gunter S. Fischer<br>Vizepräsident Deutsche Akademie der Naturforscher Leopoldina |
| | Prof. Dr. Jürgen Kirschner<br>Geschäftsführender Direktor<br>Max-Planck-Institut für Mikrostrukturphysik |
| | In memoriam – your friends and colleagues |
| 14.45 Uhr | Prof. Dr. Helmut Föll<br>Institut für Materialwissenschaft,<br>Christian-Albrechts-Universität zu Kiel<br>The life of Ulrich Gösele |
| 15.30 Uhr | Prof. Dr. Dietrich Hesse<br>Max-Planck-Institut für Mikrostrukturphysik<br>Nanoengineering of functional oxides – U.G.'s impact |
| 16.15 Uhr | Pause/*Break* |
| 17.00 Uhr | Prof. Dr. Eicke Weber<br>Fraunhofer-Institut für Solare Energiesysteme ISE<br>35 Years Research on Defects and Diffusion in Semiconductors |
| 17.30 Uhr | Prof. Dr. Sajeev John<br>University of Toronto, Auswärtiges Wissenschaftliches<br>Mitglied am Max-Planck-Institut für Mikrostrukturphysik |
| 18.00 Uhr | Ende des Kolloquiums/*End of Colloquium* |
| 19.00 Uhr | Gemeinsames Abendessen in der *Bergschenke*<br>*Get Together at Bergschenke* |

Ralph Wehrspohn, bless him, organized a "Gedenkkolloquium" and invited all und sundry to participate. Many people did come, however, Julia and the kids and practically all Stuttgarters (Seeger, Frank, Wasserbäch, Mughrabi., Urban, Strunk, ..) were not there. I was to give the memorial speech and spend a lot of time composing it. What follows is a written long version of the speech; in the actual presentation the parts in blue-gray were left out. of course, I didn't stick to the exact wording most of the time.

Part of the speech only make sense if one appreciates that I not only commemorated Uli as the likeable person and friend he was but at the same time tried to make Kirschner look as ugly as he actually is (see "*13.8 Death*" for why Kirschner deserved that).

I was successful to some extent. At the first possible moment Wolfgang Jäger came up to me and said: "I must shake your hand for what you said about Uli's military engagement".



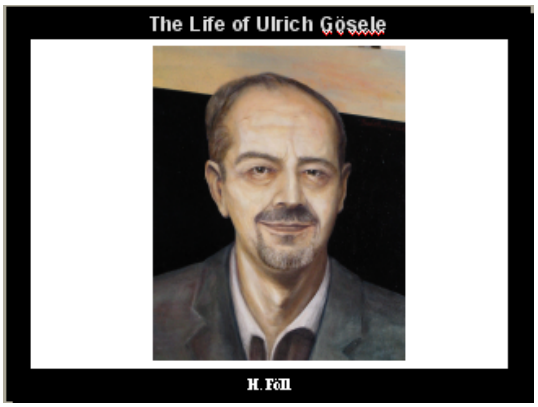
Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

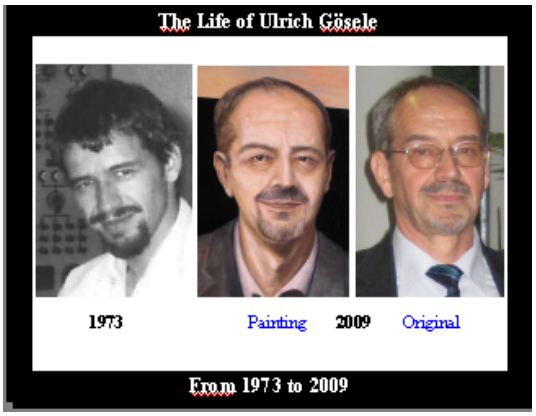
# The Life of Ulrich Gösele

**Helmut Föll**

## 1. Introduction




When I came home from work on Tuesday, November 10th, 2009 my wife told me that there was a strange message in the mailbox. Listening to it, some Julia or other said something unintelligible in German. The only thing I understood was that it concerned somehow Ulrich Gösele, and that I should tell his friends something. Running the message again didn't make it clearer so I called Ulrich's secretary in Halle, who told me that he was found dead in his apartment on this very day. I was thunderstruck to put it mildly. When I listened to the message again I now heard Julia Gösele, the mother of his three children, say very clearly: "Uli ist gestorben" (Uli died). Obviously my ears must have heard it but my brain had simply refused to decode that message, it was too far from anything conceivable by my brain.




I have known Ulrich Gösele for a long time. We were very good friends for 40 years; sometimes we did some science together. But far more important than doing science was for both of us to have fun together, and to share our aspirations, our problems, our successes and failures, sometimes our bosses, and once an apartment and car. We spend a lot of time wandering around in forests and cities, just talking. The last time we did that was less than two years ago in Honululu, Hawaii, after Ulrich presented at the Electrochemical Society Meeting our last common "paper" – the obituary for our good friend Volker Lehmann (see "*11.8 Lehmann*").

Most if not all of you have also known Ulrich Gösele in some specific capacity for some time. He may have been your boss and advisor, your colleague, your mentor, or, a long time ago, your Diploma and PhD student. Maybe he was your role model, a friend, or just another guy you couldn't avoid. You may have loved him, liked him, respected him, ignored him, envied him or even avoided him. He may have exasperated you or even



Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

made you raving mad on occasion, but I wager that he never deceived you or treated you with contempt. He neither just bossed you around, demonstrating his power or his superior intellect, but treated you as a fellow human being with the respect you deserved.

I'm confident that very few if any hated, feared or despised him, and while not everybody might have only positive associations with respect to Ulrich Gösele, I think it is fair to say that if he had personal enemies, it was not so much because he wronged them but because some people needed to rationalize their jealousy by putting him down.

What kind of person was Ulrich Gösele? I will try to remember him not just as a scientist but also as a special human being.

I'm not going to be objective; I will make this rather personal and I apologize for mentioning myself a lot. He certainly had many other friends but I only can talk first-hand about what I shared with him. I will try to show how certain idiosyncrasies and his way of conducting science have roots in his early years.

I'm not trying to glorify Ulrich Gösele but I have nothing bad to say about him either. Not only because that would be out of place on an occasion like this but also because the only critical issue I ever saw in his way of life and discussed with him, was that he overstretched himself. His jetting around the world at an alarming and increasing frequency would have been problematic for a younger person, and I'm fairly sure that this was what killed him in the end.

He pushed himself to the limit and beyond. To be sure, he did that because he enjoyed being successful and the center of attention – always provided that he felt that he earned that - but he also did it out of a deep sense of responsibility for the resources entrusted to him, and in particular for the benefit of the many people whose future depended on him. I asked him just about a year ago if he really thought that he needed yet another publication to his list. "No", he replied, "I certainly do not need that anymore - but my people need it".

## 2. From Birth to University

### 2.1 Early Years

Ulrich Gösele was born in Stuttgart on January 25th in the year 1949 – 6 days before I was born in the same general area.


1949 was not a particularly good year to come into this world but still far better than the years 1945 - 48. These years right after the war were in many respects worse than the wartime; most Germans were permanently hungry and cold in the winter and infant mortality was high. This is not as abstract as it



Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

sounds now: My elder brother, born in 1947, didn't make it; I myself only survived by a hair's breadth.


After the currency reform, introducing the DM in 21. Juni 21st 1948, things improved but it was still difficult if not impossible to feed your baby appropriately. Stuttgart and its surroundings was not as rich as it is today, in 1945 it rather looked as you see here. . While "The Germans" may have asked for it and deserved it, the tiny Germans born in 1949 neither asked for it nor deserved it; they just grew up under difficult circumstances.

My generation certainly had a difficult start but it could and would only get better - for quite some time, as it turned out. We had a chance to advance to high school in 1959 because tuition had just been cancelled. Paying money for sending your kids to school was completely out of the question for my parents, and probably also for Ulrich's parents, even so his father was a Professor. However, you didn't just switch to the Gymnasium – or High School – of your choice, you first had to pass a not-so-easy entrance exam and then survive the first three month trial period. In my case we started with about 120 students or roughly 10 % of the students body in this year, just about 40 finished 9 years later. Talk about drop out rates! For Ulrich it was rather similar. Nowadays, and I say this for the non-Germans here, about 50 % of a year goes to the High schools.

Ulrich Gösele, like me, finished Gymnasium in June 1967 and joined the university rather early in life, being only 18 years old, just like me. Since 6 (starting elementary school) plus 13 (duration of high school) + 1.5 (duration of draft for military service) equals 20.5, we conclude that he somehow managed to avoid the draft (like me), didn't have to repeat a class in school (like me but unlike most), and benefited from the "Kurzschuljahre" the shortened school years in 1966/67 because of a change in the beginning of the school year.



Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

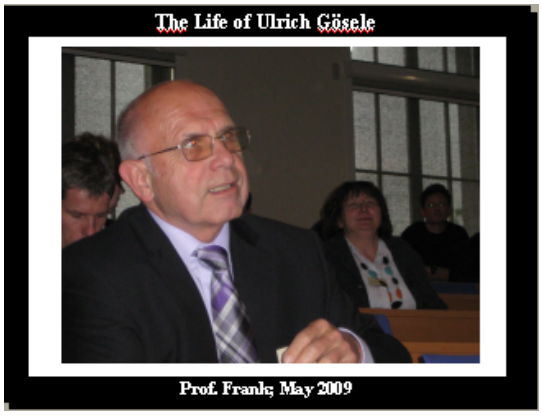
Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

## 2.2 Studying and Living in Stuttgart


Both of us started studying Physics in the fall of 1967. Of course we joined Stuttgart University; anywhere else it would have been too expensive. Stuttgart University had been just promoted to that exalted rank - before 1967 it was "only" a "Technical High School". More important, it didn't charge any tuition to speak of; otherwise I certainly wouldn't have studied.

My first memory of Uli Gösele is that I copied the solutions to the quantum mechanics exercise questions from him in **69/70**. He could do it; I couldn't. I probably have run into Ulrich earlier than that, but from then on we became friends. The decisive years in our friendship and our careers were from about 1972 – 1976, when we did our diploma work and our PhD work formally at the University of Stuttgart but in reality at the Max-Planck-Institute for Metal Physics, headed by **Prof. Seeger**. Uli had **Prof. Frank** as a mentor while I was entrusted to Prof. Wilkens.

Ulrich became a theoretician and I an experimentalist, spending long hours in the dark with an electron microscope. The general topic pursued by both of us was defects in crystals, in particular point defects, and Ulrich was acquiring fluency in modeling diffusion and diffusion mechanisms; he actually used **the** computer for that. "**The**" computer - the one and only computer of the university. It had a building and a crew of its own, was horribly expensive, and had a computing power far below that of one of our more stupid wristwatches of today. What we have today, we have **thanks to the work of Ulrich Gösele and, of course, many others**.




Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

**2.3 Growing up in Suebia**

Both of us grew up and lived for more than 25 years almost exclusively in the Stuttgart area, the heartland of Schwaben – Suebia. This forms – some might say: deforms – the character of a person to some extent. In short, and to the extent it applies to Ulrich Gösele, growing up in the Stuttgart area meant that you were exposed to what is called "schwäbischer Pietismus", Suebian pietism. This smacks a bit, and correctly so, of protestant Christian fundamentalism. While in the enlightened Stuttgart middle class the religious zeal was close to zero - for Ulrich actually exactly zero - some remnants of the general spirit were still permeating polite Stuttgart society. You were supposed to be diligent and to work hard, you had to be organized and clean - at least on the outside - and you were supposed to listen and to accept proper authority like parents, teachers, the police, and Professors. You had to pretend an affinity to high culture and to loathing trash, meaning that you read comics (of course you read the funnies) and Perry Rhodan secretly. You were supposed to be all of this and more, and of course you weren't. You challenged authority and so on, but with all our protests and youthful rebellion, some kind of honor code around those values did worm its way into our brains. Stuttgart and understatement went together, in stark contrast, for example, to Munich, just about 250 km to the southeast.

As a Suebian you could not escape dialectic reasoning, after all the Suebians Schelling and Hegel, to name just two, invented it. One always looked at both sides of a topic - the thesis and the antithesis, or, if you like that better, the complementary aspects of whatever came up. This helped to recognize flaws, uncertainties, hidden logical contradictions or just plain old superstition, prejudice and biasing. If you knew Ulrich Gösele, you know that he could not listen to a thesis without automatically working out the antithesis. Deeper insights that he gained this way, for example while listening to a scientific or political presentation, he often shared with the speaker and the audience, not always to the amusement of the speaker.

If one alloys a lustful inclination to dialectic reasoning with the pietistic heritage and some typical or at least occasional positive Suebian character traits like understatement, curiosity, diligence, global-mindedness plus a well developed sense for achieving one's goals in an indirect manner, often homing in from the back, ("henterschefür"), we have a good first approximation of the core states of a person like Ulrich Gösele.

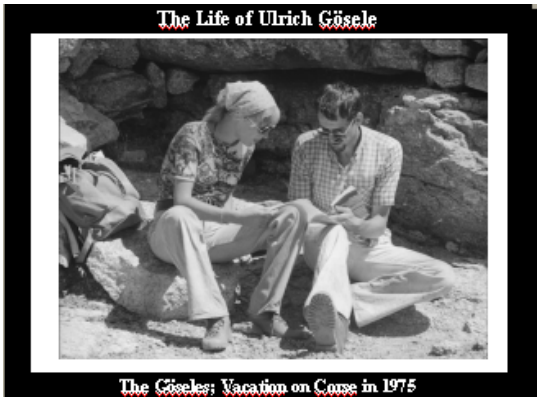


Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

## 4. Early Events that shaped his Life

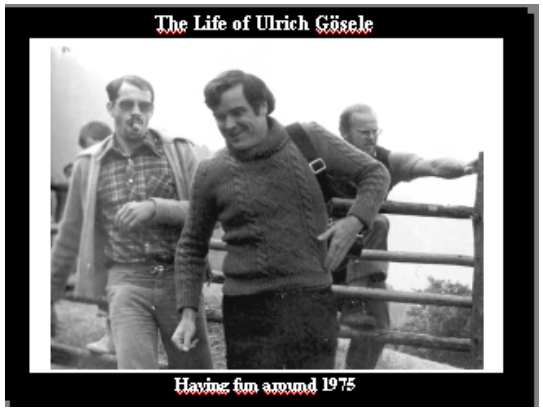
### 4.1. Early Marriage




Ulrich Gösele's first daughter Andrea was born in early 1975. Somewhat earlier, in Oct. 11th 1974, he had married Julia, his friend from sandbox times and intermittently ever since for obvious reasons: he got her pregnant.

Ulrich was about a year from finishing his PhD thesis and the good and irresponsible life that our exclusively male bachelor group had shared so far, suddenly came to a grinding halt for him. Julia Gösele was in the middle of her education as High School teacher, and the young couple was not in a position to just settle down and raise a family. He did not shrug off his responsibility for his pregnant girl friend but true to his pietistic heritage and so on, married here and struggled.

He struggled hard and neither then nor later ran away from a difficult situation. That he eventually mastered the problems encountered in his early family years increased his self-confidence, something he actually could use in those years.




While it was not a particular easy time for the young family, and Ulrich actually felt rather burdened with too much responsibility, we were nevertheless rather care free and privileged during those years. We just didn't notice it then; this insight came later.

However, we started to realize that there was a large world out there about which we didn't know much. We learned this from getting exposed to extremely alien and exotic people who came from far-away and mystic countries like Japan, India and Russia, because exchanging scientists had just started in Germany. It is hard to imagine now that you could walk through Stuttgart in 1975 without seeing anybody who didn't looking solidly Suebian, or at least German.

We started to realize that things out there were different from what we had learned or just assumed. The 1968 students uprising, while far too extreme in its basic views for us budding and sober scientists, nevertheless had succeeded to provide us with some healthy skepticism towards officialdom and unearned authority, and we started to extend that skepticism also towards political and scientific dogma.

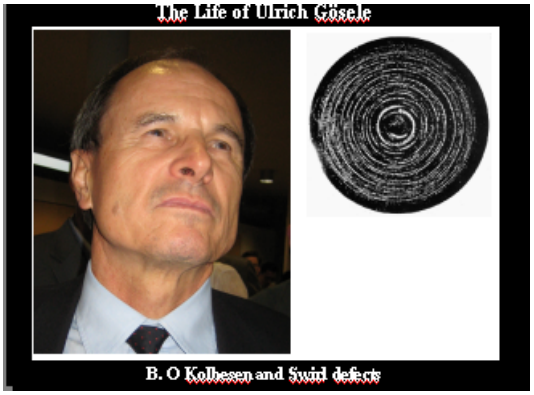


Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

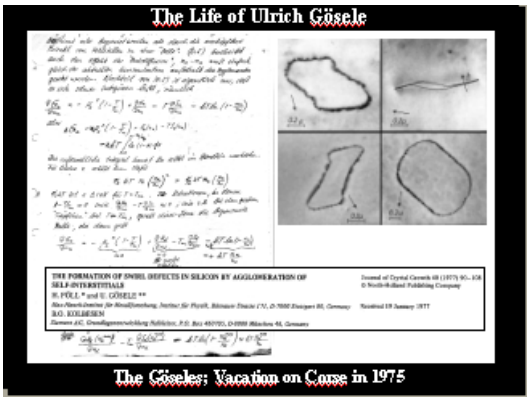
Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

It slowly dawned on us then, that we were in a rather unique or actually privileged position. We could find things out for ourselves. The world was large but open to young scientists. You actually could meander over large portions of the globe as post-docs, experience other cultures first hand while pursuing science - and you even were paid for doing this!

### 4.2. Interstitials in Silicon




In 1976 I motivated or, as he called it, bullied Ulrich Gösele into working with Bernd Kolbesen from Siemens and me on the topic of so-called swirl defects in silicon. We had just discovered that these agglomerates of native defects in large Si crystals were of the interstitial type. We lustily proclaimed the new paradigm that self-interstitials and not vacancies would be the dominating intrinsic point defects in Si, giving substance to the viewpoint, first suggested by our mentor Alfred Seeger together with K. P. Chik, that diffusion in Si involved self-interstitials. The generally accepted dogma was of course that intrinsic point defects in equilibrium at high temperatures must always be vacancies, and our heretical viewpoint was ridiculed and met with scorn.




We needed a theoretician to better understand the experimental findings, and my prodding Ulrich did succeed in turning him into the general field of defects and diffusion in semiconductors. Our first common paper contained a first theory about the formation of these so-called swirl defects. While things turned out to be more complicated than envisioned then, interstitials in Si (and by now also in other semiconductors), and interstitial based diffusion mechanisms are now textbook topics, despite strong opposition from the orthodoxy for many years. This lead – one is inclined to say: of course – to bitter and sometimes quite frustrating battles with referees. We exchanged many letters (e-mail hadn't been invented yet) discussing the best ways to convince referees and colleagues of the obvious.

I do believe that the events that lead to this and some follow-up papers substantially influenced Ulrich's scientific career and the way he understood and conducted science. Ulrich Gösele acquired not only a taste for semiconductor science and technology but also


Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

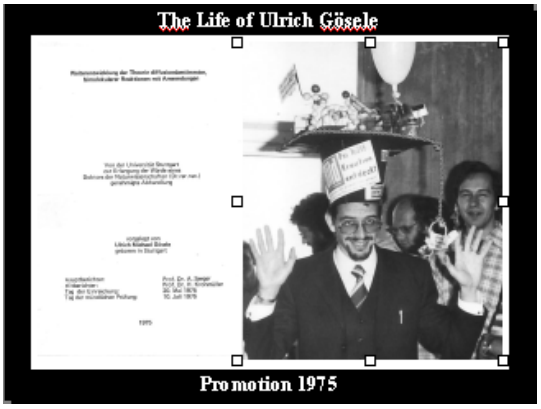
Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

for the fun of introducing new paradigms, if ever so little ones, and battling the orthodox for it. Sticking to this topic and his guns for the rest of his life, he eventually emerged successfully and became one of the leading authorities in the large field of defects and diffusion in semiconductors.

Let me quote **Howard Huff**, the well-known scientist and organizer of the major semiconductor science meetings, on this: *I had this thrill of the meetings with Gösele and colleagues in Germany as being rather similar to the meetings with the leaders of the 1920s Germany as the focal point in establishing the new Quantum Mechanics, in conjunction with key visitors from Europe, England and America. And here we were, (…) with Gösele's leadership playing a key role in the formulation and interpretation of the dynamics associated with oxygen, carbon, metallic impurities, etc. in Silicon along with oxygen precipitation, dissolving and the re-precipitation formulation. I have retained these most happiest of thoughts of this participation with Gösele and colleagues ever since!*

Being compared to the titans of Quantum Mechanics could well boost one's ego, but it is just metaphorical of course. Nevertheless, this was certainly how Howard felt and how we perceived Ulrich's work.

### 4.3. South Africa and Back




In July 1975 Ulrich Gösele obtained his Doctor degree or PhD. As one of the "high potentials" of the Institute, Ulrich stayed as a post-doc. In Oct. 1976, just when I was finishing my PhD and bullied him into semiconductor work, he joined the Physical Metallurgy Division of the Atomic Energy Board in South Africa, where he acted as the temporary head of a research group that had close ties to Stuttgart. This became necessary because the previous director had lost his life in an airplane crash. Ulrich Gösele went there on short notice, taking his newly wed wife and his first child Andrea, a less than 2-year-old toddler, along.

This incident, long past and now rather unimportant, nevertheless highlights one of Uli Gösele's special character traits quite well: he then started to develop a deep responsibility towards society and in particular towards fellow scientists. He was struggling to support his young wife, who was still finishing her own education, to be a good father to his daughter, and to work towards a career in science, and thus had no personal desire to go to South Africa with his family. However, he found himself in a position where he could do what was clearly required, and he neither then nor later subscribed to the attitude "let somebody else do it" but rather accepted some personal hardship as the price to pay

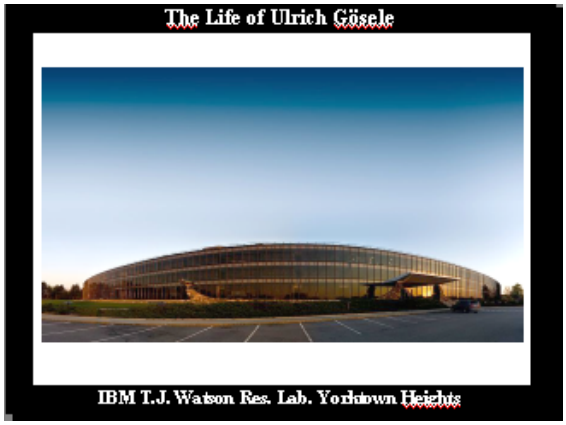


Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

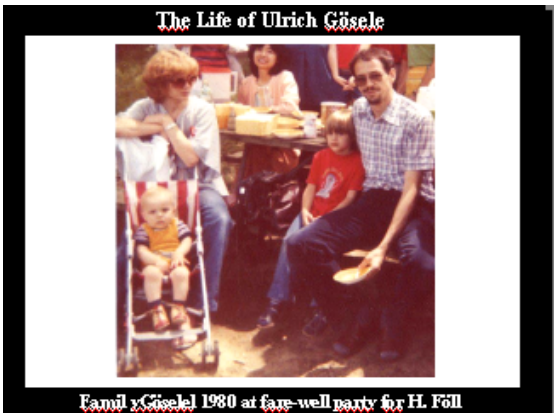
Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

for living up to his own work ethics. Again, that was certainly not the only reason to go but it might have tipped the scale.

### 4.4. Yorktown Heights and Teh Tan




In South Africa, and back in Stuttgart again, Ulrich had to focus on metal research but was keen to resume semiconductor work. For that he wanted to find a suitable semiconductor place for a sabbatical, where he could utilize his by then substantial background on diffusion and diffusion mechanisms, he finally succeeded to join the IBM Watson Research Laboratories in Yorktown Heights, New York, USA around **May** 1980. He could afford the expense of moving there with his family because in 1977 he had been awarded the Otto-Hahn Medal of the Max-Planck Society (MPG) for outstanding scientific achievements, and that award came with funds specifically earmarked for traveling abroad.




He came to Yorktown Heights just when I left it for Siemens in Munich, Germany, and we were in close contact via writing letters in preparation of his move. He took over my apartment and my car and worked for my boss King Ning Tu in the same department that I just left.

Once more he took up research topics for which I had produced some new experimental results. This time the major concern was silicide formation, but some more general issues of defects in Si also came up. One of the pressing questions, sharpened by the TEM results, was why not all phases that should be there were found in the interface region.

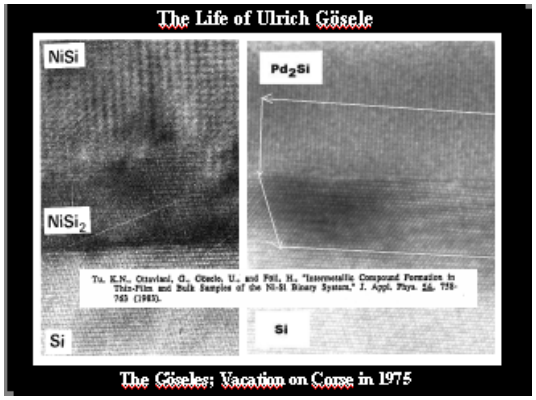
In Yorktown Heights I had closely worked with Teh Tan (now a Professor at Duke University) and introduced Ulrich to him. The two of them not only became close friends for life but also generated more than 125 papers concerning defects and diffusion in semiconductors, including seminal work on oxygen precipitation in Si crystals.

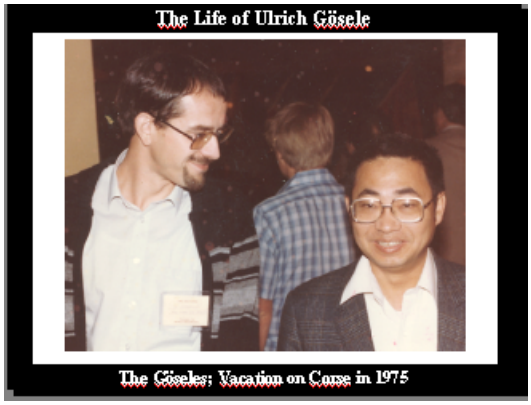
Working with the scientists at Yorktown Heights broadened and strengthened not only Ulrich Gösele's background in semiconductor science and technology but also his appreciation of experimental work, in particular including transmission electron micros-


Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

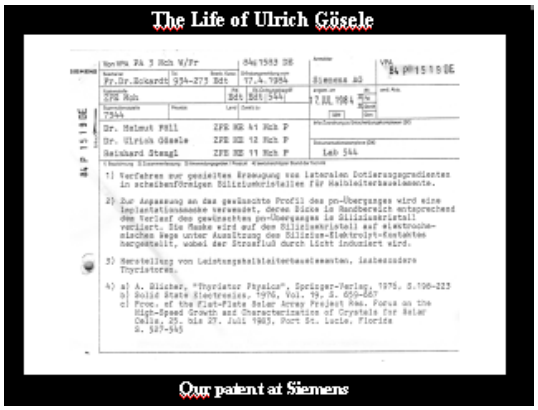
copy (TEM). While still a very good theoretician at heart, he had by now developed a deep understanding and appreciation of experimental work that made him a much sought-after partner for experimentalists. He could interpret their findings within the accepted theoretical framework, or alternatively within new and non-canonical models, since he had an exceptionally open mind that accepted only pure logic as the limit to invigorating and challenging speculations. Since he also was a good listener it goes without saying that he attracted all kinds of scientists in need of a "sparring partner" for critical discussion of their ideas




## 6. Siemens and Duke University

### 6.1 Siemens




After his year at Yorktown Heights, Ulrich went back to Stuttgart and eventually obtained his "**Habilitation**", a kind of extended second doctorate needed as a qualification for a university professorship in Germany. That was not without the typical complications well known to interdisciplinary scientists – they find themselves caught in the middle. Ulrich found himself between a rock and a hard place for a while - the theoreticians didn't accept his thesis as proper theory, while the experimentalists could not find enough experiments in it.

Around 1984, the confines of the MPI for Metals Research finally became too narrow since his main interest was now decidedly on semiconductors. The Institute, naturally, demanded that he should pursue topics in metals (like the nature of radiation induced interstitials in fcc metals at low temperatures) and stop his (successful) work on what was

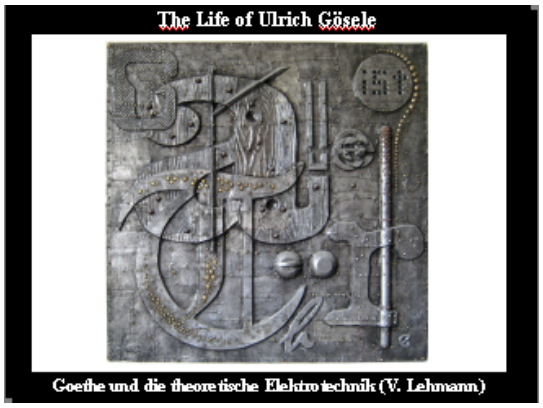


Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

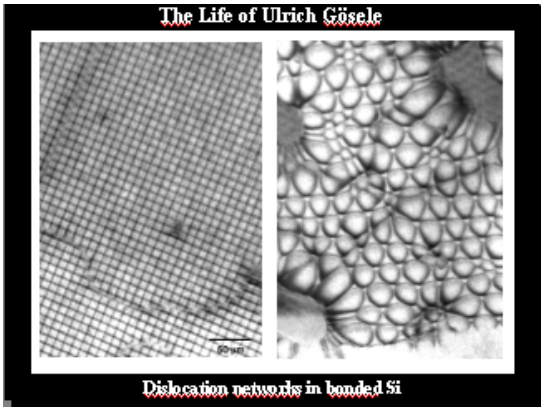
Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

perceived as “applied” research in semiconductors (like figuring out the kick-out mechanisms for Au diffusion Si). He was quite frustrated and became desperate. He looked for a way out and was even willing to endanger his career goal of becoming a Professor. He once more was willing to sacrifice the easy life for staying true to his ethics.

Based on his acute sense for “practical” science (expressed also, for example, in early publications about rather technical and practical issues in building acoustics) his extensive and well-known background in semiconductor science and technology, Siemens Corporation in Munich, Germany, hired him as a research engineer for developing power devices, and he joined the R&D branch in München-Perlach. That he had connections to Siemens from his earlier work via Bernd Kolbesen who then also worked with power devices didn’t hurt either.




As it happened, I had been working for Siemens in the same general department in München-Perlach for a few years by then, so we met again and had a splendid time together, interacting socially and scientifically. We even obtained a patent together and, most important for his future research, Ulrich Gösele met Volker Lehmann, who had been working in my group since 1982 while pursuing his diploma in electrical engineering and after that a PhD in physics. Ulrich was intrigued by a remarkable piece of art in my house, and that lead him straight to the artist: Volker Lehmann. He thus got to know my small group at Siemens that was pursuing the electrochemistry of Si “on the side”, including first attempts at pore etching.




He also was introduced to advanced Si technology, and in particular to processing requirements specific to power-devices. The idea of using wafer-bonding as a new process to circumvent grave technological problems with very deep diffusions was born during this time. We had many discussions about that topic since I actually had succeeded in “bonding” small Si pieces a few years earlier, with the goal of producing defined grain boundaries, and Ulrich was intrigued by the complex interface structures produced in this way. I advised that wafer-bonding could not do the job envisioned for power devices, nevertheless Ulrich started wafer-bonding at Duke, knowing and expecting that something would



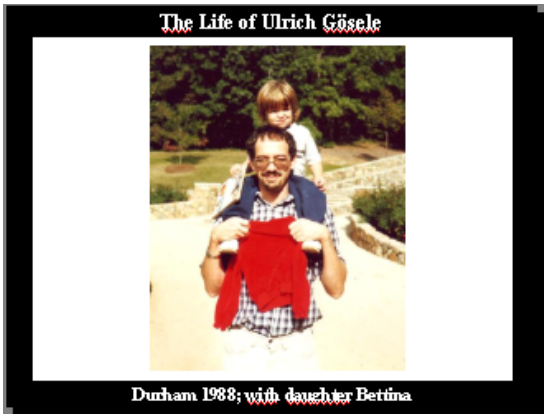
Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

come out of it. As it turned out, I was right but he was righter: Something did indeed come out of his wafer-bonding work!

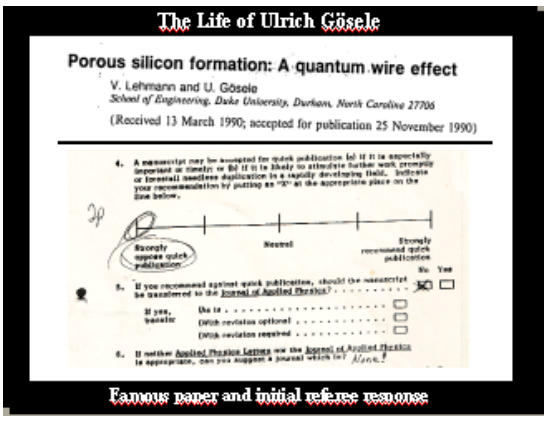
Once more he learned that applied science questions coming up in semiconductor technology, if pursued with an open mind, could easily lead to interesting science and considerable scientific challenges. He heeded this lecture ever since. He also learned that with some tenacity and luck, even impossible things could be done. One of his favorite sayings in this respect was, that if you needed the impossible done, you must give the task to a young PhD student who doesn't know yet that it couldn't be done.

### 6.2 Duke University




Ulrich Gösele stayed in Munich for just one year. Then his previous relations with Duke University, North Carolina, USA, finally bore fruit: he was offered a full Professorship in Materials Science. Since he preferred independent research to a career in a company that ultimately would move him from research towards management, he accepted and moved with his family to America in 1985.

At Duke University he resumed working on general defects and diffusion issues but also started two new research areas that were based on his experience at Siemens as just pointed out. For wafer bonding he established a viable process outside of an expensive clean room for doing that, actually with the help of "post-docs" from Siemens including Volker Lehmann and Reinhard Stengl.




The second area was electrochemistry of Si including pore etching. He was acutely aware of the potential of this field that had sprouted practical application like the "ELYMAT" but also of a growing number of puzzles like the formation mechanisms of various pore structures that posed a challenge to a semiconductor scientist. The decisive step was to induce V. Lehmann to join him for a year as a post-doc in 1989.

He kept up work in both areas until his untimely death and installed himself as one of the leading experts in these by now large fields. As far as porous semiconductors are concerned, his 1991 paper "Porous Silicon Formation – a Quantum Wire Effect" (to-



Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

gether with the late V. Lehmann) is still his most cited paper with more than 1,000 quotations. Of course, one is tempted to say, it was first violently turned down by a referee ("zero out of x points, strongly oppose publication").

V. Lehmann became a good friend and their cooperation lasted until the tragic death of Volker in 2006. The events around the publication of this paper are recounted in his own words in our last common paper eulogizing V. Lehmann. This paper also recounts a long and for Ulrich Gösele not altogether savory story around a patent that went with it. Suffice it to say that Ulrich Gösele learned that while you can't win against large government organizations head-on, because this quickly turns into a quantitative contest of who has more money, you could beat them on quality - by doing superior research.

## 7. Basic vs. Applied Science


The topic basic vs. applied science has come up repeatedly so far. Let me give you a bit more on that. Being at a Max-Planck Institute we did – of course – basic science, and we didn't even know that there was some other kind.

A major topic of Basic Science in Stuttgart was to worry about the precise geometric arrangement of the metastable low-temperature configuration of radiation-induced self-interstitials in fcc metals. This was basic science because there was no conceivable use for that, if we neglect the fusion reactor, something that one could safely neglect then and now.

Applied Science, in stark contrast, was to worry about the nature of point defects in Si. This was applied science because those point defects are the vehicles for diffusion in Si - and diffusion in semiconductors was and is one of the cornerstones of semiconductor technology and thus the foundation for a major industry. This implied that you might even get funding from companies for your research, a definite indication that whatever you did was applied Science.

The scientific dogma in Germany was, and in some minds still is, quite simple: Basic science is good, applied science is bad. Taking money from companies then is akin to prostituting yourself.

I'm being polemic on purpose but will take some time out now to mention that there are good and honorable reasons for this peculiar German attitude, coming right from the infamous role of science and industry during the Nazi time. Hans Queisser's book "Kristallene Krisen" still provides for interesting reading in this context. I do not try to ridicule anybody who for good personal reasons elects to do only basic science, but I do not accept that this choice puts down a moral law or a value scale for all.


Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

Nobody outside Germany has ever understood why self-interstitials could only be a legitimate topic of interest in crystals where they are of no consequence, whereas in Si and other semiconductors those very self-interstitials must not be touched. Ulrich Gösele, I myself, and some others didn't understand that either. We figured, for reasons alluded to before, that the best one can hope to achieve as a scientist is to introduce a new paradigm, and even a little paradigm in "applied" science like "interstitials in semiconductors matter" is better in the sense of being more fun than just explaining complex basic things in terms of existing paradigms, no matter how much effort that might take.

Prof. Seeger let us roam pretty freely but we were exposed to and felt this fundamental dichotomy of German science - and we didn't quite like it. What came out of it is that Ulrich Gösele learned early on that in Germany you may have to fight for your right to do interesting and challenging science if that happened to be defined as "applied" science by the mainstream, or just by self-appointed guardians of pure science.

I'm sure that his early experience with regard to this issue made him impervious to criticisms of this kind, and I sincerely believe that this was all for the good of his department - and for a large number of young and gifted researchers, who would never had had the chance to pursue their advanced education in such a first rate scientific environment as the Max-Planck Institute of Microstructure Physics in Halle, without the substantial third party funding available through his unwavering commitment to interesting and challenging science instead of just dogmatic science. There are, moreover, no doubts in my mind that this was even good for the MPG.

## 8. Max-Planck-Institute in Halle


In 1991, the Max-Planck-Society (MPG), the top basic research organization in Germany, offered him a position as one of the two directors for the newly founded Max-Planck-Institute for Microstructure Physics in Halle - a flattering recognition of his ability and achievements. However, this offer also posed a considerable dilemma.

After the reunification of Germany on October 3rd, 1990, the Institute of Solid State Physics and Electron Microscopy of Prof. Heinz Bethge in Halle, one of the few world-renowned research organizations in former socialist East Germany, was deemed to be an appropriate corner stone for one of the new Max-Planck Institutes planned for the new States of unified Germany. The offer to succeed Heinz Bethge and to build up a Max-Planck-Institute honored not only Ulrich Göseles's scientific achievements, which were well known by now, but also recognized his ability to do outstanding work with experimentalists: the position was actually for the



Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

head of an experimental department. Ulrich Gösele, still well versed in theory, was finally accepted as an interdisciplinary scientist.

Ulrich Gösele now had to make a very difficult decision between two equally attractive (or unattractive, as the case may be) positions – that was the dilemma. He, and in particular his family that included by now three children, were deeply entrenched and at home in North Carolina, and his career potential at Duke University was as promising as it could be in the American scientific system. On the other hand, as the head of a MPG Institute, he would have complete freedom to do only the research he wanted to do, unencumbered by all the other duties demanded at universities. Moreoever, he woud be in complete control of a sizeable permanent staff, and – for American standards – extremely good permanent funding. The city of Halle, unfortunately, was situated in one of the most run-down and dreary areas of the former East Germany, and the quality of life in these surroundings was not high in 1991. His family abhorred the idea of settling down there and Ulrich Gösele was faced with a difficult choice. We discussed the pro's and con's a lot and I know that the fact that he finally accepted the offer is at least partly due to his aforementioned ethics and his acute sense of reponsibilty for science and scientists. He strongly felt that the West had a moral obligation to help the East, and that one could not shrug off one's own duty in this matter if called upon and defer it to "somebody else".

I'm not trying to glorify Ulrich here. His sense of responsibilty was certainly not the only reason why he went to Halle. The antithesis to "Can't somebody else do it" is, of course, "If I don't do it, somebody else will" – and reap in the possible rewards. Ulrich Gösele while certainly not given to vanity, was not completely immune to recognition and status either – who is? - and therefore tried to optimize his personal efficiency. Nevertheless, all his decisions in these matters were always based on Suebian pietist work ethics: you simply didn't back off hard work, didn't bulldoze others out of your way, and you tried to be helpful to those in need. I'm not saying that his feeling that he could and should help the East was the one and only reason why he accepted the offer, but in a mix of pro and cons that included in the pro side of course status and recognition, it may well have been the argument that tipped the scales.

His family moved to Halle with him but did not feel welcome and at home. Some nasty experiences of his chidren who met with general histility toward "foreigners" finally triggered a separation – his wife and his children moved back to the USA. While this was not a happy situation for all concerned, Ulrich Gösele never failed to support this family - not only from afar but by frequently visiting them in North Carolina while at the same time keeping up relations with colleagues from Duke University.

Accepting the offer meant transforming a rather run-down place to a cutting-edge research institution. Even more challenging, it meant having to identify able but generally rather frustrated scientists and staff among the far too many employees left over from the socialist past, integrating as many of them as possible into the new institute, and instilling into them a new sense of pride and motivation. Many West Germans faced similar assignments in the years after reunification in all branches of society, and far too often



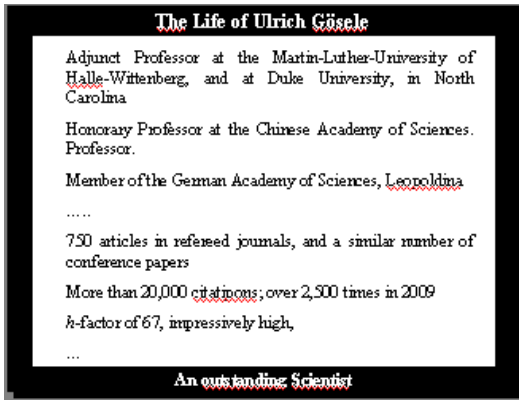
Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

many East Germans felt estranged and unappreciated as a result. I'm sure some of you here know exactly what I mean.

Not so in Ulrich Gösele's department „Experimental Physics II" in Halle. His group soon prospered and grew; all indicators for success in doing first-rate science were met with flying colors as the years passed by.

## 9. Ulrich Gösele – an outstanding Scientist?




**I** mourn for Uli Gösele as my friend with whom I had many positive and fun experiences. In fact, looking back, it seems that we spend far more time fooling around together than doing science together. While I do not remember anything whatsoever about a conference on Hawaii in 1992 or so, I vividly remember how Uli Gösele and I were trying to outdo each other with crazy, but not obviously so, theories about strange stuff (actually Pele's hair) that we found while hiking around the volcano national park.

But we also mourn for Uli Gösele as an outstanding scientist who was a reliable source of inspiration and collaboration. Let me dwell a little on what, exactly, promotes a just-so scientist to an outstanding scientist? Of course, there is the measurable record:

We have 750 articles in refereed journals, and a similar number of conference papers, which have been cited collectively more than 20,000 times, including over 2,500 times last year, leading to an h-factor of 67, which is impressively high in the field of solid state physics and semiconductor physics. We have honor positions like the adjunct Professorships at the Martin-Luther-University of Halle-Wittenberg, the Duke University in North Carolina, as well as a Honorary Professorship at the Chinese Academy of Sciences, the membership of the German Academy of Sciences, the Leopoldina, and so on; I will spare you the enumeration.

There are some who would claim that all of this is not really a measure of good or even outstanding science. Another definition, encountered mostly in Germany, for doing outstanding science is: Outstanding research is i) confined to pure or basic research, and ii) to whatever I do. Basic research, of course, counts mores than applied research; the only thing worse than that is military research.

Max Planck Institutes are supposed to do basic research, which in my definition, that also would be the definition in large parts of the civilized world out there, is foremost challenging and interesting research. This includes research in areas with no conceivable applications in the foreseeable future and anybody engaging into only this kind of research is absolutely entitled to this. But it does not exclude challenging research in areas with



Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

foreseeable applications, and nobody is entitled to criticize those who do it. It does not even exclude "military" research. Ulrich was convinced of that, and I think I have made clear how he arrived at his view of science and why he was not bowing to pressure to change his ways.

That this pressure was very real is evidenced from the following statement of the advisory board in 2007:

*Prof. Gösele has now publicly announced that in 2007 and beyond he will reduce third part funding by about 60 % and publications by about 30 %. In this context the advisory board deems it necessary to comment on the "applied" part of the research in Prof Gösele's group and on the projected future thereof.*

*Within the MPI "Mikrostrukturphysik" in Halle, the "Experimental Department II" under Prof. U. Gösele has always played a special role because the department was and is particular active and quite successful in pursuing projects in what is called "applied" science in Germany, often in collaboration with companies. Reviewing the period from 2001 – 2006, it cannot be overlooked that > 90 % of all third party funding accrued within the MPI Halle in this time was flowing into Prof. Göseles department, resulting in a workforce that was larger than that of the other two departments combined, and a matching large number of publications.*


*While the numbers are impressive, the advisory board holds that only the quality of the projects can be taken as guiding principle for the evaluation. Some of the smaller projects and a couple of the bigger projects might be doubtful in this respect; some were obviously accepted in order to help in the development of the state of Sachsen-Anhalt, even if the department did not profit very much. As long as those projects are on the fringes of Prof. Gösele's large department, there is no reason for action, and future activities in this direction should be left to Prof. Gösele's discretion.*

*Besides looking at some of the scientific highlights in more detail, this report also includes a brief evaluation of the more "applied" research that has been performed in 2001 – 2006 to the extent that it can be judged from the available information.*

*From the numbers given, third party funding (without direct funding of personnel) exceeded 12 Mio € in the time span from 2001 – 2006. 48 projects with a relatively small direct cash flow were funded from the DFG or the VW foundation and thus are biased to basic research by definition. Discounting a number of small projects typically financed by state agencies or by companies, the bulk of the third party funding flowed into projects from federal ministries (7.3 Mio €; BMBF and BMWI) and the EU (1.7 Mio €). Screening the topics and goals of these projects reveals that most of them center on research, some on research and development or just development, and that only a small number can be*



Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

*truly called "applied" in the sense that little generation of new knowledge can be expected in their execution.*

*However, most of the projects containing a development (or applied) part are of high quality and can be expected to enrich the basic research of the department since "applied" research, done on a high level and based on a basic science background, will very often lead to feedback circles that inspire novel basic research fields. The history of semiconductor technology in general, and the scientific curriculum of Prof. Gösele in particular, bear sufficient witness to this fact. In a practical sense, mixing more applied and fundamental research in one department also may have an invigorating effect via cross-fertilization on the research personnel.*

*In total, the advisory board, while not questioning the prerogative of the director to change the direction of his group in the way he announced, feels that the Max Planck Institute as an entity will not benefit from such a move as he announced. It strongly urges all directors of the Institute and the Max Planck Society, to find ways to mitigate the proposed changes and to maintain the wide and the diverse spectrum of the Institute, including its "applied" part, in the future.*

I wish he had done what he announced. If he would have cut down on raising money and pushing publications, and thus also on working and running about the world like crazy; he might still be alive.

Yes, Ulrich Gösele was an outstanding scientist, not only because he did outstanding science but also because he instilled a sense of what science means and how to do it in a large number of PhD students and others who passes through his department. He knew, lived and passed on to anybody willing to listen that all men and women are equal with respect to scientific truth. From his own experience he knew that even a seasoned scientist might be wrong on occasion. He always tried to convince others of what he knew or thought to be true and he would never have ordered his scientific staff to subscribe exclusively to his view - or else.

I think his legacy in this field is just as important as his direct impact on science and it many well survive far longer.



Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

**10. Military Research and the Privileges and Responsibilities of Scientists**

Ulrich Gösele was accused - no other word is appropriate - to have an affinity to military research. If applied research is inferior research, military research is even worse, it is dirty and evil. This is, once more, a very German attitude with honorable roots going back to the role of German scientists in the world wars. However, if that dogma would be a general truth, most of our American colleagues would be inferior and evil scientists because most are funded to some extent by some military sources.

Ulrich could defend himself any more so I'm going to do it. All I want to say is: German Lawmakers made sure that a Max-Planck-Institute director is completely free in what he or she wants to do and, moreover, that he or she is given a substantial amount of money that less privileged people had to work for and that, in Germany, often comes from industries based on applied research. These lawmakers didn't do that to please a rather small number of qualified people but because they expected that this would be good for Germany. The lawmakers who provided for this – very wisely as I believe - the very same lawmakers also considered it necessary that Germany has armed forces and that our young men, our sons actually, are drafted to the military, like it or not. They are expected to serve their country, exactly like MP directors, just in another and altogether rather less pleasant way.

I think that this means that all of us have some responsibility for our soldiers and our sons, and this "all of us" includes scientists, even MP directors. I do not for a second believe or claim that this means that whoever is in a position to do so, now must conceive better weapons for shooting and bombing. I do not even claim that whoever is in a position to do so, has a responsibility to help supplying them with equipment like radar or sensors for finding out if they are being shot at - even so one could make a reasonable case for this claim. I do claim, however, that there is nothing whatsoever dishonorable in getting involved as a scientist in conceiving better sensors for exactly that purpose and not only for purely civilian use.

We are talking responsibility here, more precisely the responsibility of a publicly paid scientist for society. Again, one can take the attitude "let somebody else do it", and I would accept and honor the decision of anybody to keep out of anything remotely smacking of military for whatever reason, even if he or she would have been in a position to contribute. I do not, however, accept that such an honorable but private dogma is seen as the only honorable way to deal with the issue.

As far as I know it, all the purported military activities of Ulrich Gösele where conceived along this line, in particular because some of the nano-science done in his department could be of possible use for sensors, and because in the USA this is now major research topic. It's not unlike the like basic vs. applied science issue: Working on sensor principles for CO or $CO_2$ is good and acceptable, using the same principles for poison gas or anthrax bacteria is evil. That is once more an arbitrary and illogical dogma, and Ulrich, as we all know, didn't suffer illogical pronouncements easily but fought them nail and tooth.



Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

I'm not saying that Ulrich planned to do military research at all but if he did his motivation included a deep sense of responsibility towards our young men and women. Again, his Suebian heritage of being dialectically inclined supplied him with the antithesis too: "Easy money for interesting and ethical research but from the ministry of defense – why not?", but he most certainly was not irresponsible about this issue but exactly the opposite.

Ulrich in his later years had realized that he belonged to a privileged group of people - like certainly I, and possibly you. We started humble, with Germany quite down, but for our generation it only got better and better. We could get a very good education, lasting 20 years, essentially for free – no tuition of any kind, we could immerse ourselves into cutting edge science with the best in terms of teachers and mentors as well as equipment and infrastructure at our disposal, we could roam the world and make friends all over, and so on and so forth – and all if this was paid for by hard working and tax-paying Germans, who for whatever reason could not make it to being a free and irresponsible scientist.

Well, as we know now, there is no such thing as a free lunch forever, and at some point you start to feel that you have a debt towards society. Ulrich felt it, and while he had no undue guilt feelings about his privileged status, he did try to live up to this responsibility. He knew and accepted that as a Max-Planck director his first duty was to pay back the trust and resources given to him by doing excellent research - and that he did. But he also felt that there was no reason whatsoever to top this off with activities that were beneficial society at large, the state of Sachsen-Anhalt, the City of Halle, the fledgling solar industry in the neighborhood, the nearby universities, and so on. If that is seen as behavior unbecoming a Max-Planck-Institute director, I think that the MPG has some explaining to do.



Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.

## 11. The Message of The Tan


Prof. Dr. Teh Yu Tan from Duke University, Ulrich's close friend as related before, has asked me to read a few words to you:

*On this solemn occasion, I shall say a few words to celebrate the life of Professor Ulrich Gösele. Among so many whose lives have been touched by Professor Gösele, I am especially privileged for having the opportunity to collaborate with him since the Summer of 1980 up to today—this is almost 30 years.*

*As it is a public record, I shall not dwell on Ulrich's scientific achievement, but instead say a few words that sums up the Ulrich I have known of. Towards research, I found Ulrich to be always open and critical minded. Ulrich is never in the habit of defending to death of one's own pet theory or conclusion, but always with a healthy degree of self-criticism, which is a rare trait few posses now a day. More important, towards people, including friends, colleagues, students, and everyone else, Ulrich had always taken a warm, enthusiastic, beneficial, square, and fair attitude. Again, these are rare qualities among achieved scientists.*

*Ulrich's death was (and still is) a big shock to me. For the first time since I left my childhood behind, I cried because of a friend. And it is still difficult for me to fully comprehend or to accept what had happened. For these few months after his death, when I hear a knock on my door, I would automatically expect to hear his voice calling "Hello, Teh", as he would do every time he came to my office. And, just the other day, without my eyeglass on, I saw a lean and tall figure walking toward me in my office corridor, I called out "Hello, Ulrich". Of course, that was not to be…. Sad as it is, I know that Ulrich is alive in my mind and heart and also in the minds and hearts of many others.*

I have nothing to add to this.



Office of Prof. U. Goesele
MPI of Microstructure Physics
Weinberg 2
06120 Halle, Germany

Prof. Dr. Ulrich M. Gösele,
Direktor am Max-Planck-Institut für Mikrostrukturphysik
Halle, verstarb am 8.11.2009.