6. Christian-Albrechts-Univesität zu Kiel; Technische Fakultät; Research

6.1 General Remarks

6.1.1 My New Job in Kiel

- Kiel, the capital of Schleswig-Holstein is about as far away from Munich, the capital of Bavaria, as you can get in Germany. As far as “Münchener” are concerned, it could be just as well on the moon. People in Kiel are strange, talk in a weird way, and just not quite right. After all, up there in North Germany they still killed (and ate?) the Christian missionaries who made it all the way to the North when the monasteries in Bavaria were already rather large and rather decadent. It is also totally flat up there, no mountains top speak of.
  The people in Kiel actually talk more or less High German and it is Munich that is totally flat. True, there are substantial mountains 100 km south of Munich, but next to Kiel is the town of Mönkeberg (Monks mountain) and that’s were we lived since the end of 1991. True, the “berg” in Mönkeberg goes only up to 50 m, perhaps, as measured from see level, but then the sea level is right there – we have a nice beach!
  Moving myself plus my wife and three kids (aged 5, 3. an 0,5 years) to Mönkeberg was one of the best things we ever did. No regret.
  - So in the fall of 1991 I was a full professor and supposed to lectures innocent kids just out of high school about the intricacies of Materials Science. As the founding Dean I was also supposed to produce an entire Faculty of Engineering (with 50 professors plus lots of normal people) from scratch (when I came, the faculty comprised 3 people including me). As a professor and chair holder I was also supposed to do research and this chapter deals with that only. The next chapter will cover teaching and some other happenings.
- What kind of experimental research can one do while being fully occupied by being the founding Dean of a new faculty that, moreover, had not yet any rooms, equipment or personnel? Not much, obviously. But as time progressed, conditions improved (because I saw to it) and research work started again. Of course, the topics I picked at the very beginning centered around the “ELYMAT” and pore etching in silicon. I had hired some staff and lucky I was because my co-workers proved to be very competent.
  - Let me give you a flavor of how that worked by looking at the first 4 publications with Kiel people on it:

74 FÖLL, H., LEHMANN, V., LIPPIK, W.: Characterization of single and polycrystalline silicon by extension of the ELYMAT technique. Proc. of the Satellite Symp. to ESSDERC '93 Grenoble, "Crystalline Defects and Contamination: Their Impact and Control in Device Manufacturing", (ECS Proc. Vol. 93-15, 1993), p. 252
V. Lehmann second author, brilliant scientist, and very good friend with whom I have worked very closely together still worked for Siemens in Munich
Wolfgang Lippik was my first PhD student and performed not only miracles in the lab but taught me HTML in the early days of the Internet and thus had a large part in the emergence of the so-called “Hyperscripts of AMAT”.
One of the chairmen of the "Satellite Symp. to ESSDERC '93” was **Bernd Kolbesen**, another prominent researcher and very good friend with whom I have worked closely together. He left Siemens a bit after me and became a professor at Frankfurt university.

75 CARSTENSEN, J., LIPPIK, W., FÖLL, H.: Mapping of defect related bulk and surface properties with the ELYMAT technique. In Semiconductor Silicon/1994 (eds, H.R. Huff, W. Bergholz, K. Sumino),(ECS Proc. Vol. 94-10), San Francisco 1994, p. 1105 (8 citations)
Jürgen Carstensen is a theoretical physicist whom I hired as a post-doc. Whenever an equation appears in one of “my” papers, it is most likely from him. I would have been lost without him and managed to move him on to a permanent position.

76 CARSTENSEN, J., LIPPIK, W., FÖLL, H.: Mapping of defect related silicon properties with the ELYMAT technique in three dimensions. Proc. of "Semiconductor Processing and Characterization with Laser-Applications in Photovoltaics", Stuttgart 1994, Mat. Science Res. Forum Vols. 173-174, p.159

- So far we have ELYMAT stuff. But quite soon a new topic came up

77 GRÜNING, U., LEHMANN, V., OTTOW, S., BUSCH, K.: Macroporous silicon with a complete two dimensional photonic band gap centered at 5 µm. J. Electrochem. Soc. (1995) (291citations)
Dipl.-Phys. Ulrike Grüning did PhD work at Siemens under the guidance of V. Lehmann. Stefan **Ottow** was “my” PhD student at the time. He also spend some time in Munich, working with V. Lehmann.
Kurt Busch was one of the big guys around “photonic crystals”, and that was a topic that I was forced into by my extremely good friend **Uli Gösele**, then the director of the Max-Planck-Institute for Micro Structure Physics in Halle, Germany.
Note that I'm not an author. Nevertheless, I could not escape the new topic "Photonic Crystals" that appears here for the first time

- What we learn is: My netwrok was not very large but powerful.

6.1.2 Research in Kiel - Overview

- My general **research topic** is easily named: **Electrochemistry of semiconductors**.
  - Strange, considering that I always hated electrochemistry when I was a student and that I never had the feeling that I understood it.
    Now, after 45 years of researching the topic, I know why I always felt ambiguous to the field. It is simply not understood very well. Let's do a thought experiment: Take some semiconductor with known doping, immerse it into some electrolyte, apply some voltage – and now predict *without actually doing the experiment* what is going to happen. That simply can't be done in most cases, neglecting some trivial exceptions.
    On the other hand, that leaves a lot of room for actually doing experiments. And a lot of room for experiencing big surprises and finding rather involved physics around buzzwords like "self-organization" and "phase transitions". Moreover, one also finds lots of potential applications, allowing to file for plenty of patents.
- My general obsession with semiconductor electrochemistry centered around the following topics

1. Improving the "ELYMAT" and eventually abandoning it in favor of "***CELLO***" Cello stands for "solar CELl LOcal characterization" and, in contrast to the ELYMAT, needs not to employ electrochemistry. It uses, however, involved impedance spectroscopy methods that we developed primarily for electrochemical systems.
2. Investigating pore etching in Si, Ge, GaAs, InP, ...,
3. Inventing and developing the "current burst" theory to understand selforganizations phenomenae at semiconductor electrodes. This is actually more than some theory but a new paradigm for parts of electrochemstry.
4. Looking at various applications of pore etching in semiconductors; in particularat at producinge a superior anode for the Li ion battery.
5. Miscellaneous. A small part of part of my research work. Look, for example, at publ. No. 1116. 117. 118. 130, 160, 172, 209, 210, ..254, 286