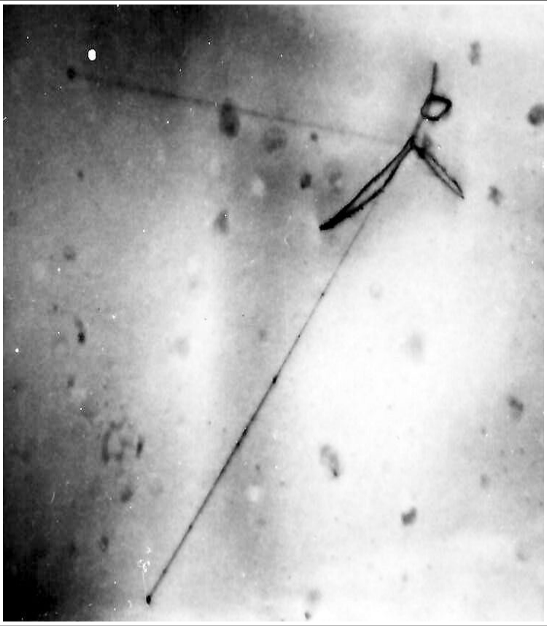
Pictures to: 2.3 Swirl Defects in Si (Investigated in a HVTEM)

Part 2

- A large number of the A-swirl defects found hart ab extremely complex structure. There are explanations for this but some questions remain unanswered.
  - In the following I give several examples without much comment. Read the publications if you are interested. Note that not all dislocations
    are shown due to contrast conditions. Faint lines including, on occasion a few "dots" (small precipitates) are likely to denote dislocations out of contrast.



Here we see how complex structures start out
Loops become elongated and very long dipoles are pulled out of the center.
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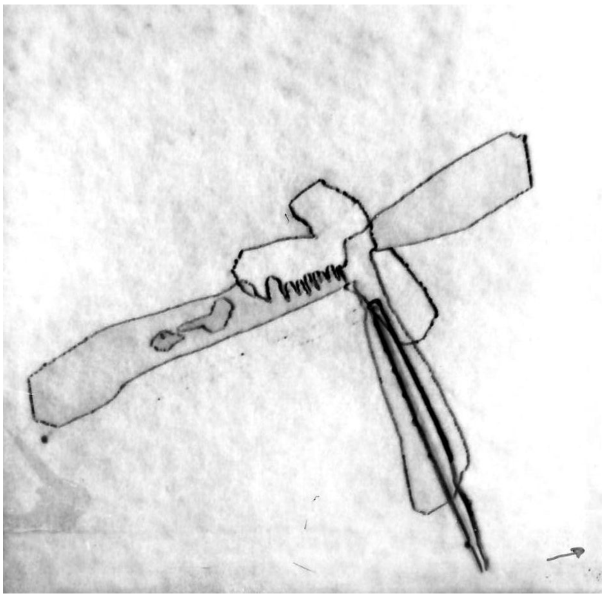

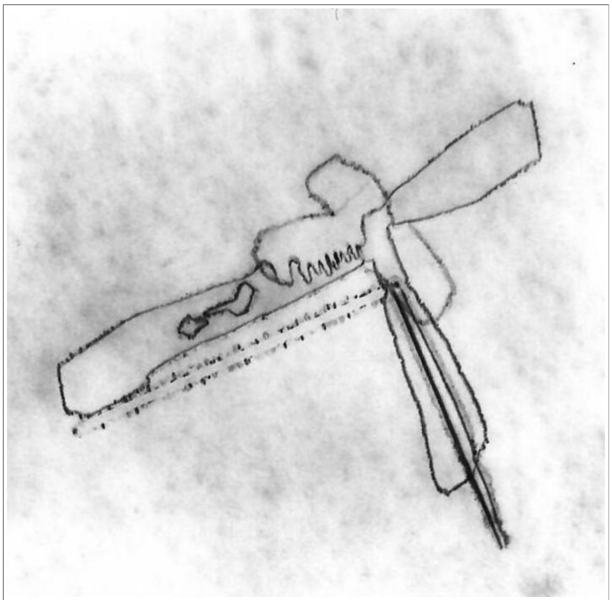
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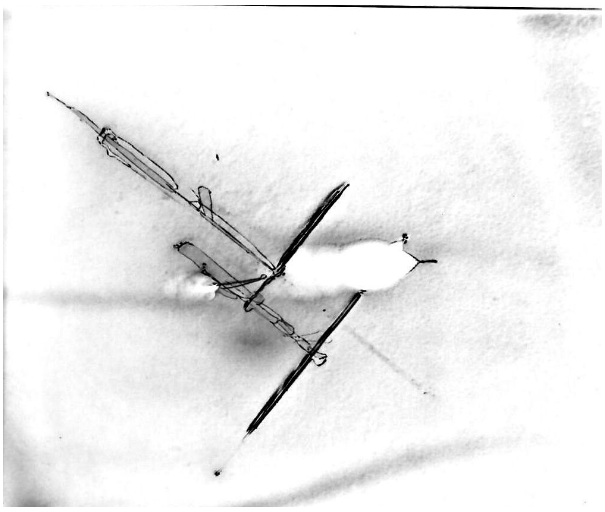
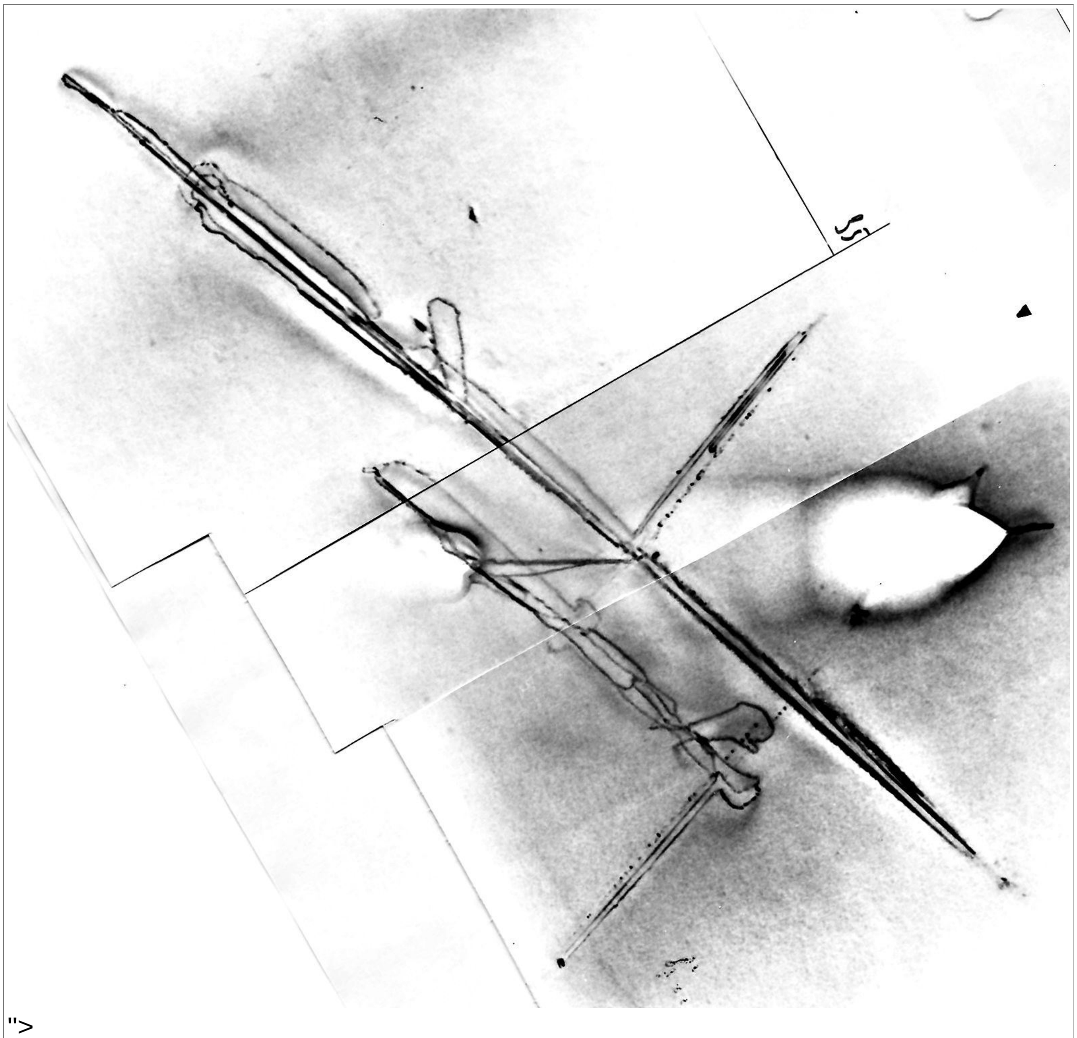
Similar to the one above
Imaged with 2 different diffraction conditions
Possibly showing some climb of screw dislocation parts (The zig-zag structure center left)



It's getting complicated. Where a dislocation reached the original surface, an etch pit develops.



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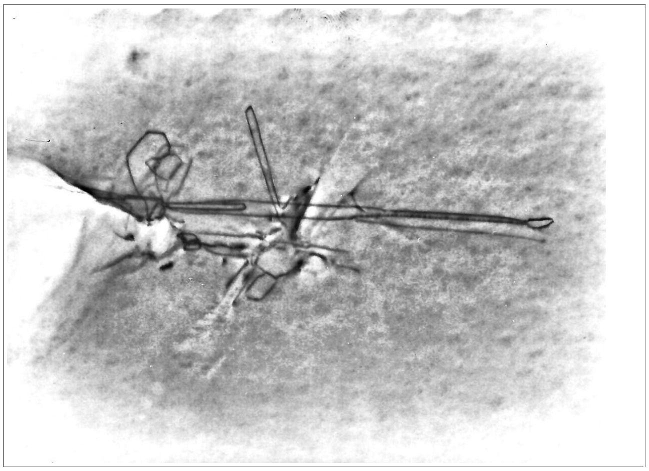
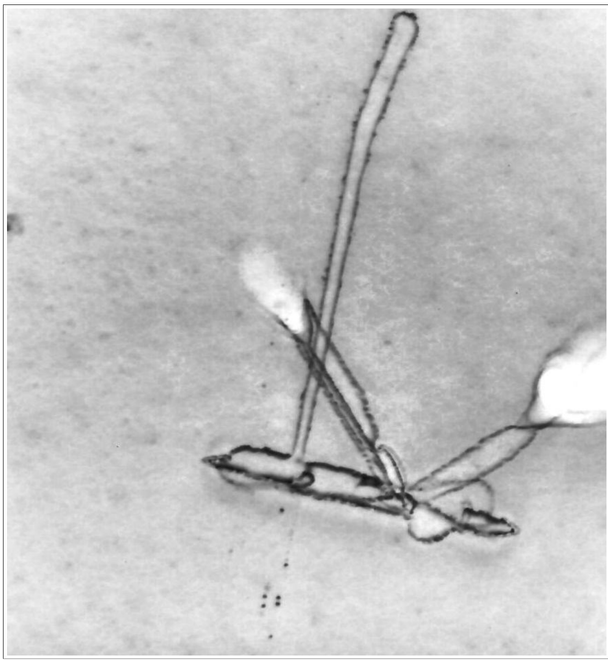
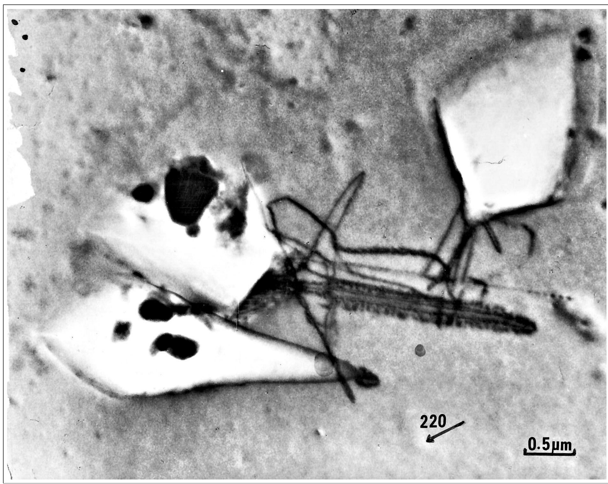
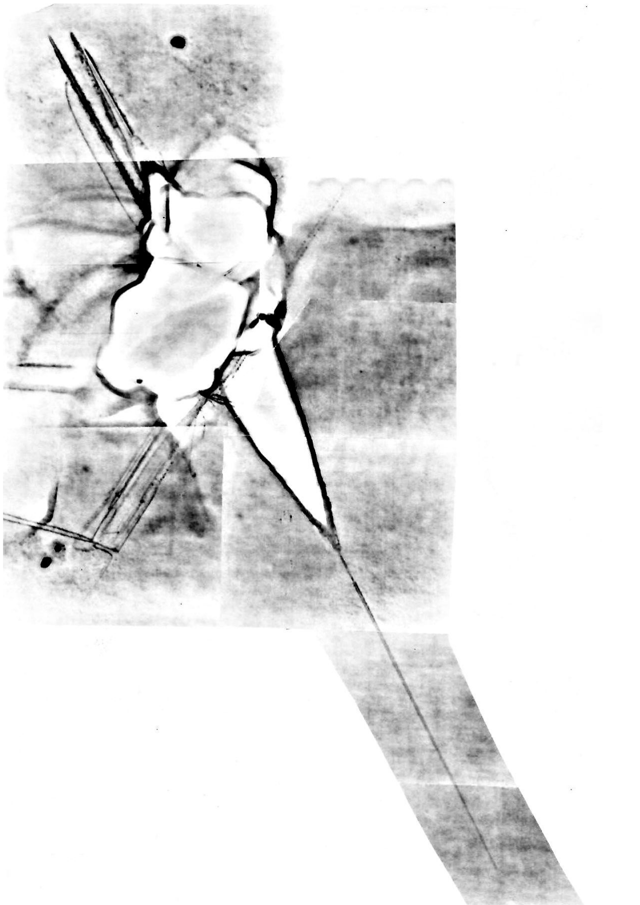
Same as above.
Different diffraction condition



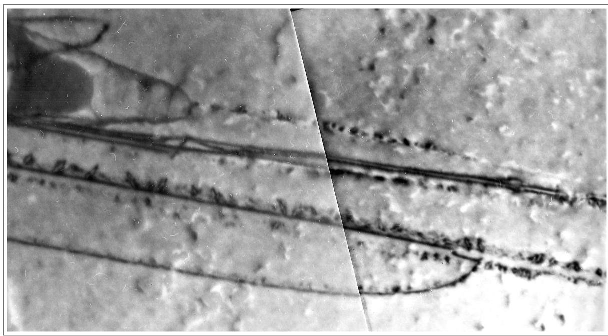




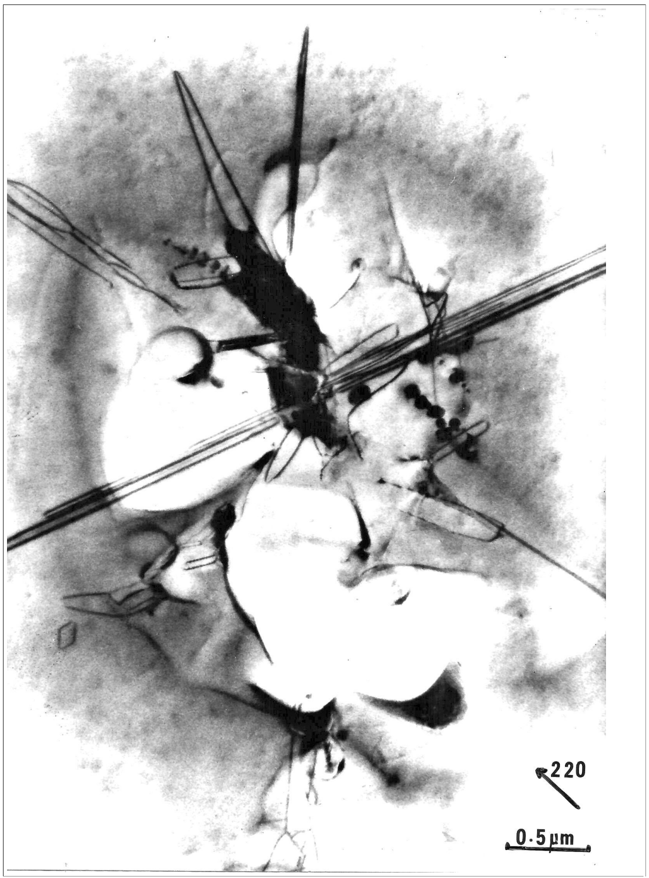
Frequently long dipoles are decorated with small dislocations loops.



A "monster", already too large to be fully contained in the specimen.

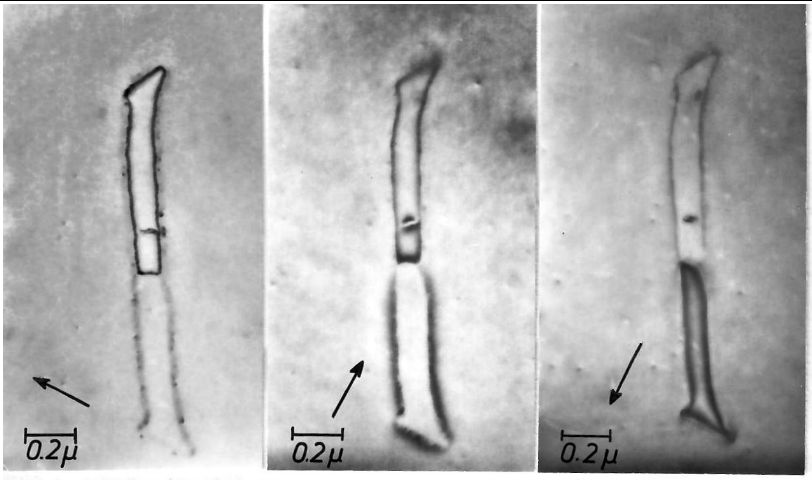


Detail of the "monster" from above..
The "things" decorating some of the dislocations lines might be precipitates but do behave like small dislocation loops of the interstitial type in involved contrast analysis.



The ultimate monster
Demonstrates nicely what we learned then and again and again
in years to follow: Some supersaturated point defects in
silicon – self-interstitials, vacancies, foreign atoms like oxygen
, carbon, iron, nickel, …, are not doing much if they don't find
some help in nucleating some agglomerate. If nucleation is
possible, however, huge defects (always deadly for devices) may
develop out of almost nothing. Controlling or better preventing
nucleation is thus the key for making working integrated circuits

Finally, some pictures, drawings and text about loop analysis straight out of my thesis



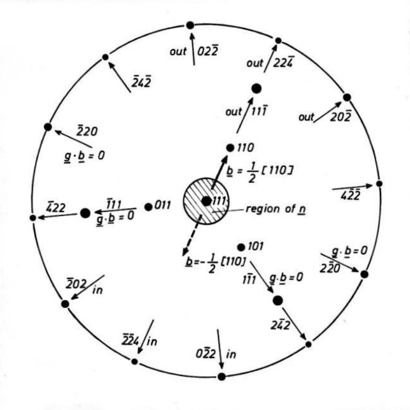
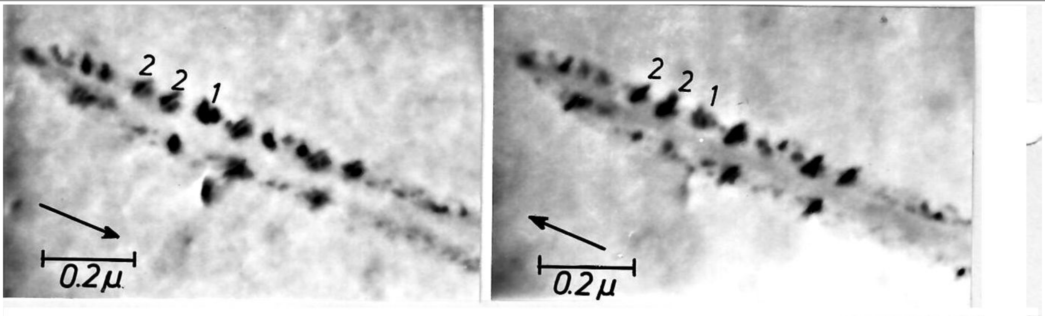


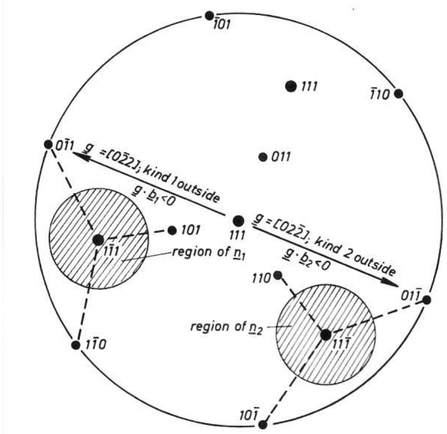
Bild 3.9

Beispiel einer Analyse.
(a) Bestimmung des Burgers=vektors des unteren Ringes ($\underline{g} \cdot \underline{b} = 0$). (b) und (c) In=side ($\underline{g} \cdot \underline{b} > 0$) bzw. Outside Kontrast mit einem {422} Beugungsvektor. (d) (111) Polfigur zur Illustration der Ringkonfiguration. Nur $\underline{b} = -a/2[110]$ erfüllt die $\underline{g} \cdot \underline{b} \cdot s$ - Regel, d.h. $\underline{n} \cdot \underline{b} < 0$, der Ring ist vom Zwischen gitteratomtyp.

(Aus Föll und Kolbesen (1975))

How to determine the Burges vector and the type..
Note that typically 10 - 20 pictures were taken to be on the safe side
Read the publications for detail



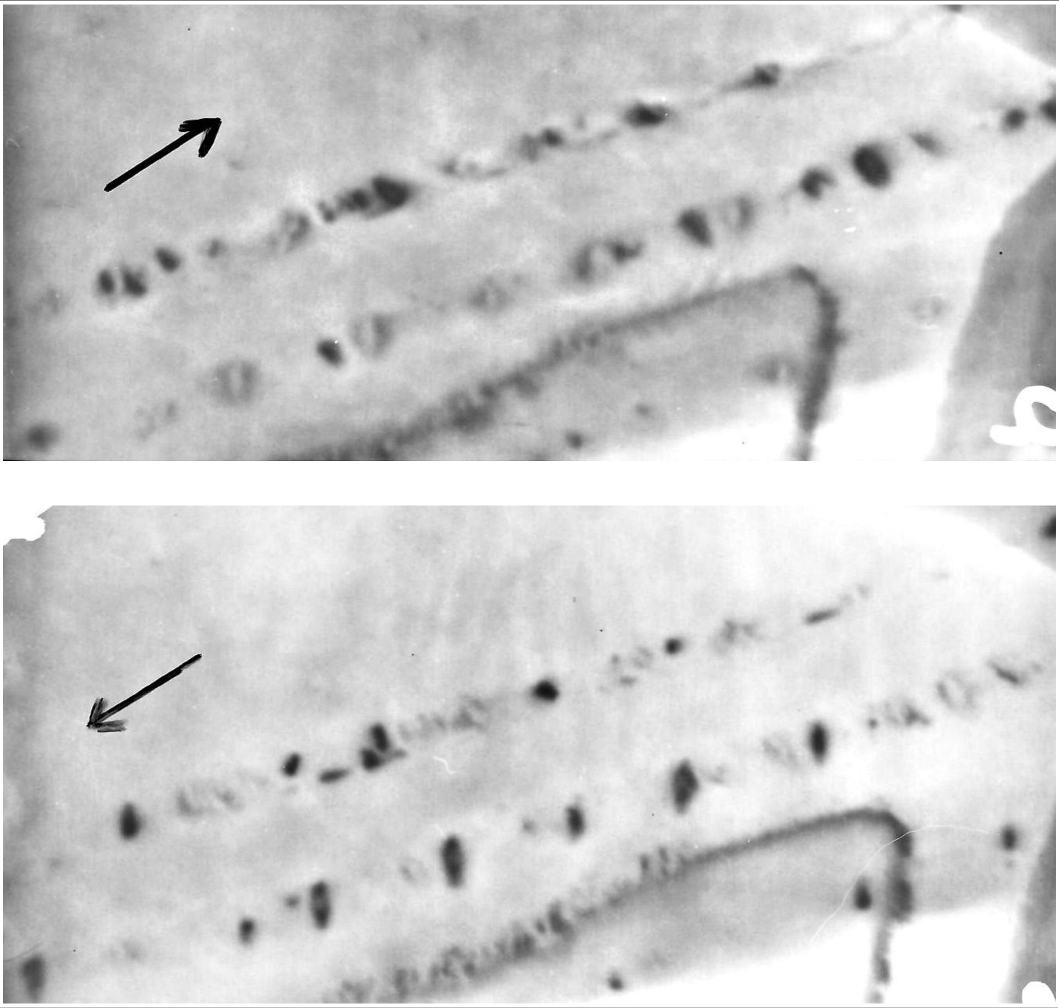


(Aus Föll und Kolbesen (1975))

Bild 3.10

Beispiele von analysierten kleinen Ringen
Ringe auf zwei verschiedenen Ebenen sind sichtbar, bezeichnet mit "1" ("kind 1") und "2" ("kind 2"). (a) und (b) Inside - Outside-Kontrast=experiment. (c) (111) Polfigur mit den möglichen Ringkonfigurationen. Alle möglichen Kombinationen von $\underline{n}$ und $\underline{b}$ sind mit gestrichelten Linien markiert. Die $\underline{g} \cdot \underline{b} \cdot s$ - Bedingungen sind für alle möglichen Kombinationer nur für Versetzungsringe vom Zwisch gitteratomtyp erfüllt.

Analyzing the small dislocation loops.
Can you see the inside - outside contrast behavior? This takes already the famous "eye of faith" .
The important small details were already lost in these small micrographs intended for publication.



Inside - outside contrast experiment with small loops.
Now you can see it!

Here are the links to the rest

[Swirl pictures](#)
[Part 1](#)
[Part 3](#)