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Advances in silicon crystal properties

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Current silicon material technology mainly is focussed on two different trends:

a) The quality of electronic-grade silicon gradually has to be adjusted to the performance requirements of the fast growing LSI and VLSI device technologies

b) For future application of photovoltaic energy conversion a new type of silicon (solar grade) is developed on a low-cost basis

Material quality always has been strongly correlated with device yields. Due to much smaller geometries in microelectronics, these are increasingly dependant on defects in dislocation-free material. There are two categories of defect patterns, which will be discussed here in more detail: "swirl" and "haze".

The first-named group of defects has been investigated worldwide for more than ten years now. Based on the principal topography of growth-related microfluctuations in the crystal, three different situations are discernible:

1) Pointlike defects in as-grown material

2) Defects being developed after a first heat treatment

3) Defects as a result of a more or less complex device processing sequence

Attempts will be made to indicate the influence of material properties on the development of such defects.

Much less is known about the nature of defects being characterized as "haze", or "fog". Their phenomenological appearance mainly is that of tiny shallow etch pits. An interesting feature of such defects is their rather high thermal mobility. A gettering system, therefore, can be applied advantageously to remove them either by its chemical nature or strain field gradients. Backside damage, as the most widely used gettering procedure in silicon wafers, will be discussed in more detail.

In photovoltaics, one of our special approaches to make low-cost silicon is the casting of polycrystalline ingots. A most interesting problem here is the interaction of more or less mobile defects with grain boundaries. Preliminary results on this particular subject will be reported.