# Service and development of future crystal growth technologies - the activities of the IKZ in Berlin

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During the unification of the two German states, in January 1992, the Institute of Crystal Growth (IKZ) in Berlin was founded. As "nucleation centre" two departments with-long term crystal growth experiences of the former Academy of Sciences in East-Berlin were merged into this new common institute. The IKZ started its activities by a considerable reconstruction and enlargement of the supply of equipment for crystal growth, crystal preparation and characterization. But the main task of Foundation Committee was the discussion of the focal points for the future research and development work at IKZ. Responding to the recommendations the aim has been directed to bulk and epitaxial growth of crystalline materials, beginning from basic research up to technological realization in the industry. Today the activities of about one hundred co-workers focus on the following topics: silicon, Si-Ge, SiC, GaAs, GaP, ZnSe, $GaPO_4$, oxide crystals for lasers, non-linear optics and various substrates, numerical simulation, crystal characterization and development of growth equipment. Meanwhile a new building of IKZ is under reconstruction. The removal is assigned for the end of 1997. As such the IKZ could be seen as a one of a kind institute in the world [1].

For the growth of 4-5 inch Si crystals with a length of about 1.5 m and 1-2 inch Si-Ge mixed crystals by the floating zone technique, there are five pullers developed by the IKZ in cooperation with industry. For the growth of Ge-Si crystals with diameter of 35 mm and lenght up to 300 mm a self-constructed Czochralski puller is applied. Furthermore, nine automatically controlled Czochralski pullers of different producers and, additionally, top seeded solution growth machines are employed for the growth of III-V compounds and a large number of different oxides (doped and undoped garnets, fluorides like $LiCaAlF_6$ and $LiSrAlF_6$, YBCO substrates like $SrPrGaO_4$, polar crystals, substrate for GaN epitaxy like $LiAlO_2$), respectively. Numerous controlled furnaces with different numbers of heat zones are employed for the vapour growth of II-VI crystals (ZnSe). The LPE of silicon and GaP layers is carried out by four machines. Recently, a project on growth of Si crystallites on glasses by combined CVD-VLS deposition was started. For the crystal analysis various characterization methods are employed: light microscopy, IR absorption techniques, pholuminescence, x-ray analysis, atomic force microscopy, electron microscopy, electron paramagnetic resonance.

After the introduction in the activities of the IKZ the presentation will show some newer results of the development of bulk crystal growth technologies especially for semiconductor materials. Dislocation-free $Si_{1-x}Ge_x$ crystals with x up to 0.09, 35 mm in diameter and 300 mm in length were grown by a modified floating zone technique successfully [2]. Monocrystalline 2 inch $Si_{1-x}Ge_x$ (0>x>0.12 and 0.92<x<1) crystals were grown by the Czochralski method with a refilling technique and automatic diameter control [3]. Some results of ZnSe vapour growth [4] and various oxide crystals [5] will be demonstrated.

The attention will be focused on the growth of 3 and 4 inch semi-insulating GaAs crystals with low and homogeneously distributed dislocation density applying different inert gas pressures [6] and, the more favoured, vapour pressure controlled LEC method [7,8]. This promising method for the future materials basic of the opto- and microwave-electronics was developed in Japan some years ago. A modified inner growth chamber for a low temperature gradient and with an arsenic source for the preventation of the surface dissociation of the growing crystal was developed. It will be demonstrated that 3 and 4 inch GaAs crystals, grown at IKZ, show a low near homogeneously distributed dislocation density of $\leq 10^4$ $cm^{-2}$, a very high surface quality like metallic luster, the absence of Ga inclusions, a larger diameter of subgrain cells and low residual mechanical stresses. Some outlooks will be given.

In addition the IKZ is cultivating the current teaching of young scientists and specialists from other scientific institutes and industry in the field of fundamentals of crystal growth. Triennial national summer schools on crystal growth with international participations are organized since 1996. Moreover, numerous lectures are given at further international schools by specialsist of the IKZ. Generally, the IKZ cares for close international cooperations. Contracts ar concluded with the Fukuda Laboratory of IMR of the Tohoku University in Sendai (Japan), the Institute of Electronic Materials Technology in Warsaw (Poland), Adv. Silicon Ma. Incorp. (USA), for example.

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