Keynote Lecture

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Defect mastering - one of the topic challenges for crystal growth

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The quality of single crystals, epitaxial layers and devices made there from are very sensitively influenced by structural and atomistic deficiencies generated during the crystal growth. Crystalline imperfections comprise point defects, dislocations, grain boundaries, second-phase particles. Over more than a half-century of the development of crystal growth, most of the important defect-forming mechanisms have become well understood [1-2]. As a result, the present state of technology makes it possible to produce crystals of remarkably high quality. However, that is not to say that all problems are already solved. For instance, in comparison with silicon the point defect dynamics in semiconductor and oxide compounds is not nearly as well understood. The density of equivalent defect types and antisites in each sub-lattice is determined by deviation from stoichiometry. Their charge state depends on the Fermi level position leading via interaction with dopants to certain compensation level and complex formation. One measure proves to be the in situ control of stoichiometry. Due to high-temperature dislocation dynamics heterogeneous dislocation substructures are formed. Both, acting thermo-mechanical stress and given point defect situation force the dislocation to glide and climb. In the course of enthalpy minimization the long-range character of dislocation interaction produces agglomerates and patterns with polygonized cell walls, i.e. small angle grain boundaries [3]. Thanks to the rules of correspondence of Taylor and Kuhlmann-Wilsdorf one is able to estimate the interaction between shear stress, dislocation density and cell diameter (Fig.). In epitaxy the Nye tensor, describing dislocation distribution inhomogeneity, affects the layer stress considerably. The growth under minimum stress, solution hardening and in situ stoichiometry control are effective counteracting methods. One of the most serious consequences during cooling down of as-grown crystals is the point defect condensation in precipitates and micro-voids decorating dislocation patterns or inducing high mechanical misfit stress that generates dislocation loops. It proves to be favourable to anneal the crystal a few degrees below the melting point in order to dissolve the particles and re-diffuse their into the crystal matrix.

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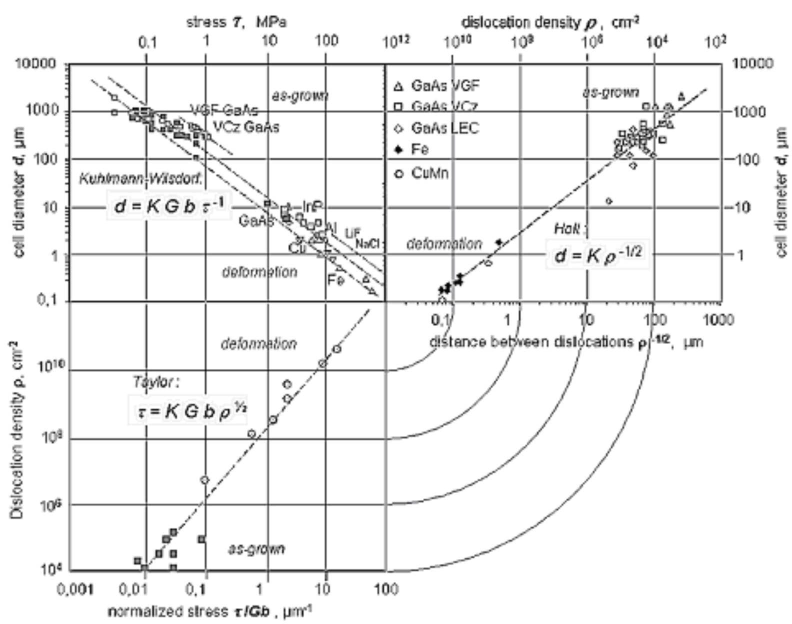

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