Computational Solid Mechanics Studies on Material Strengths of Single Crystals for Electronic/Optical Use

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Various single crystals such as semiconductor single crystals (Si, GaAs, InP, etc.) and oxide single crystals ($LiNbO_3$, $LiTaO_3$, Al_2O_3 , etc.) are used as materials for electronic and optical devices. Such bulk single crystals are manufactured using the melt growth methods such as the Czochralski (CZ) method, the Bridgman method, the floating zone (FZ) method, and so on. As the melt growth of a bulk single crystal is carried out under sever thermal conditions, large thermal stress is induced in a crystal during crystal growth. Such thermal stress causes the generation and multiplication of dislocations that affect the performance of electronic/optical devices, and sometimes induces macro-carcking. Micro-defects such as dislocations and macro-cracking should be controlled during crystal growth to obtain high-quality bulk single crystals. Solid mechanics and material strength studies on the manufacturing process of single crystals and electronic/optical devices are of importance to solve the problems related to the generation and multiplication of dislocations and the cracking of single crystals. My presentation will review such research activities that comprise the thermal stress analysis and dislocation density estimation during crystal growth and ingot annealing, and the cracking of single crystal due to thermal stress.