Crystal growth: from bulk to microcrystals.

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Crystal growth is an amazing activity. It is one field usually not directly classified as physics in view of chemistry and materials engineering approaches, however, for a deep understanding of crystal growth, required to achieve the fabrication of useful crystalline materials, basic principles of physics are needed. Thermodynamics is essential to understand a phase diagram denoting equilibrium states plotted as functions of temperature and concentration, fundamental parameters on crystal growth. The heat and mass transport phenomena also play a significant role in crystal growth theory and in the control of defects in crystals hosts. The knowledge about the arrangement of atoms in solids (crystallography) and the influence of the crystals geometry is also relevant. The crystallographic direction may be a main parameter on the defects propagation or growth rate during the fabrication of a single crystal. In view of multi-phenomena and multi-scale interactions present in crystal growth process, advances in this field have been driven by a combination of experimental effort (motivated from new devices and applications), characterization process and development of theoretical models. The present work aims to discuss the motivation for, some important early results, and some current works of our laboratory on bulk and micro crystal growth. We review the crystal growth technologies employed (Czochraslki, Zone melting and micro pulling down) and describe progress of our group in the last years in optimizing crystal growth of fluorides ($BiYF_4$, $LiYF_4$, BaY_2F_8) and tungstates ($NaLa(WO_4)_2$, $LiLa(WO_4)_2$) materials aiming the development of optical applications (mainly laser hosts and scintillators). The requirements with respect to size and quality of crystals for different applications and with respect to complexity of crystal growth problems are discussed based on thermal, optical and structural characterizations of the obtained samples.