

## Poster Sessions

the crystal diameter increases into c-axis direction. In contrast, when the electric power applied to the a-axis of crystal is stronger than the electric power applied to c-axis of crystal, the crystal diameter increases into the a-axis direction. As a conclusion, to get the round shape crystal, the electric power of the lamp applied into a-axis direction of crystal should be stronger than c-axis direction of crystal.

Keywords: crystal growth, float zone growth, vanadium compounds

### P16.09.33

*Acta Cryst.* (2008). A64, C590

#### Chiral and achiral mechanisms of regulation of calcite crystallization

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The regulation of calcite mineralization by chiral biological molecules is one of the fundamental unresolved issues at the interface between biological, geological, and physical sciences. Here we address the role of chirality of L-aspartic acid (L-Asp), a model additive, in the regulation of the calcite growth. We apply phase-shift interferometry to non-intrusively monitor *in situ* the morphology of the surface and quantify the velocity of propagation of the steps, during crystallization. Similar to complex behavior observed before, L-Asp leads to several-fold increase in the step velocity, in all directions, at low supersaturations, and several-fold slow down at high supersaturations. L-Asp also introduces asymmetry in the velocity of steps of related by mirror symmetry, however, of less than 10 %. To explain the complex effects of L-Asp, and, likely, of other biological regulators of calcite crystallization, we show that prior to incorporation into steps, calcium and carbonate ions adsorb on the terraces and diffuse towards the steps. L-Asp accelerates the surface diffusion towards the steps, an achiral process, likely due to rearrangement by L-Asp of the structure of the water coating the calcite crystal surface. Importantly, L-Asp delays by about 20 times the incorporation of calcite ions into the steps, the only chiral process in the calcite crystallization mechanism, likely by blocking a significant fraction of the kinks. We show that the low asymmetry between the two chiral directions due to attenuation by the surface supply fields of the steps. The results and analyses presented here suggest that the chiral effects of bio-generated molecules on crystallization may be too weak to judge about biological or non-biological origin of minerals.

Keywords: chirality, calcite, *in-situ* observation

### P16.10.34

*Acta Cryst.* (2008). A64, C590

#### Formation of barred olivine texture 4.6 billion years ago

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Most of chondritic meteorites falling onto the Earth contain mm-sized crystalline silicate spheres (chondrules), which are believed to have been formed from molten silicate droplets 4.6 billion years ago in our early solar system. Some of them have interesting textures with rim and bars. The rim has a thin shell-like morphology surrounding a chondrule. The bars are planar crystals parallel each other observed inside the rim. The remarkable features are that the rim connects with bars and the crystal orientation of the rim is the same as adjoining bars. Such texture has not been reproduced in the laboratory experiments except a few examples, therefore, the formation mechanism is unclear. We notice that the Mullins-Sekerka instability at the interface between the previously formed rim and the inside melt results into the formation of bars based on the linear stability analysis of Mullins and Sekerka (1964, *J. Appl. Phys.* 35, 444). We numerically simulate the crystallization of a supercooled silicate droplet by using a phase-field model. For simplicity, we consider a droplet of one component in our model, so we solve the equations for evolution of phase and temperature fields, but do not the equation of concentration. Initially, we assume that the rim is formed at the droplet surface. Since the rim is heated up to about the melting temperature by the release of the latent heat of crystallization, the temperature gradient from the hotter rim to the cooler inside is generated. In this situation, the interface between the rim and the inside melt is unstable during the solidification. Our simulation shows that the instability grows nonlinearly and parallel planar crystals are formed. This morphology is very similar to that observed in some natural samples of chondrules.

Keywords: crystal growth of silicates, supercooling, instability

### P16.11.35

*Acta Cryst.* (2008). A64, C590–591

#### Property and morphology of organic modified CeO<sub>2</sub> nanocrystals synthesized in supercritical water

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We proposed a new method to synthesize organic-inorganic hybrid nanoparticles at supercritical hydrothermal conditions. By introducing organic legands (aminoacids, carboxylic acids, amines, alcohols, aldehydes etc.) into supercritical hydrothermal synthesis atmosphere, organic -inorganic hybrid nanocrystals are synthesized. For the case of CeO<sub>2</sub> nanocrystals, nanocubes with 100 surface could be synthesized. It is the first report that CeO<sub>2</sub> nanocrystals with 100 surface that has extremely high catalytic reactivity can be synthesized. With increasing the amount of surface modifier, shape of the nanocrystals was changed to truncated octahedron with 100

## Poster Sessions

and 111 surface and the particles size was reduced. The valence of Ce was measured. With decreasing the size of the nanocrystals, valence of Ce was changed from 4 to 3. FTIR analyses revealed that the chemical bond between the surface modifier and 100 surface and 111 surface are different. Ab-initio calculation could successfully explain all of those experimental results.

Keywords: supercritical fluids, hydrothermal synthesis, organic inorganic hybrid materials

### P16.12.36

*Acta Cryst. (2008). A64, C591*

#### The role of Japanese twin boundary in quartz as a source of Brazil twin

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Growth textures and atomic configurations of Japanese twin boundary in quartz were studied by using optical microscopy and computational simulations. Samples from Narushima, Nagasaki Prefecture, Japan were polished, etched by hydro fluoric acid for several minutes, and coated by evaporated silver. From observations by reflection microscopy, hourglass-shaped sectors are found near the composition plane of Japanese twin to have mosaic textures composed of polysynthetic Brazil twin. Especially high concentration of Brazil twin with a repeat scale less than 1 micro meter is observed in a growth sector where composition plane of Japanese twin is a straight {112} plane. Atomic configurations at {112} composition plane of Japanese twin were simulated by using molecular dynamics simulations and the energy minimization method. The initial atomic configurations are two slabs of the bulk crystals and simulations were performed for all the different displacements of slabs. From the simulated structures, the twin displacement vector was determined for each of 10 subtypes of Japanese twin. In the case of Brazil twin, the twin displacement vector is known to be a function of orientation of the composition plane. Therefore, screw dislocations are necessarily present where orientation of Brazil twin boundary changes from one orientation to another. Based on the twin displacement vectors of 10 subtypes of Japanese twin determined in this study, we found that dislocations are also required at stepped boundary of Japanese twin, whereas dislocations are not required where Japanese twin boundaries intersect with Brazil twin boundaries. Observations in this study indicate that {112} composition plane of Japanese twin serves as a source of Brazil twin during the course of crystal growth.

Keywords: quartz, twin boundary, molecular dynamics

### P16.04.38

*Acta Cryst. (2008). A64, C591*

#### Preparation and characterization of cadmium telluride thin films by vacuum evaporation

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Cadmium telluride thin films are prepared by vacuum evaporation of CdTe powder using an Edwards 306 coating unit. Calculated

quantity of copper is evaporated on top of CdTe layer. The whole assembly is then annealed at 400 °C for 4-6 Minutes. The thin films are characterized optically and electrically using spectrophotometer and measurements of van der Pauw & Hall Effect. Characterization of CdTe has shown it to have a band gap of 1.475 eV and a resistivity of 0.132 to 0.002 ohm-cm, depending upon the concentration of copper. As the weight percentage of copper increases the resistivity decreases and the mobility increases up to 3 wt% of copper. The carrier concentration showed a systematic increase.

Keywords: thin films, deposition, XRD

### P16.04.39

*Acta Cryst. (2008). A64, C591*

#### Synthesis large-scale high purity InP crystal by P-injection method

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Polycrystalline InP is the starting material for InP crystal growth by Liquid Encapsulated Czochralski (LEC) and Gradient Freezing (GF) Technique. Hence, polycrystalline must therefore be pre-synthesized prior to crystal growth. A large quantity of high purity InP crystal material has been produced by the phosphorus in-situ injection synthesis and LEC growth process. In the injection method, phosphorus reacts with indium very quickly so that the rapid polycrystalline synthesis is possible. It also has an easiness to increase the production scale, so that the method is very promising for the large-scale production. This method however has a difficulty in obtaining stoichiometric polycrystalline because the cease point of phosphorus injection is difficult to find. For realizing this method as an industrial method, the stoichiometric control is one of the key technologies to be developed. It was found a suitable thermal distribution on injector tube and melt are necessary for the synthesis of stoichiometric InP with such a large quantity. The quartz injector with two or multi-transfer tubes was used to improve the synthesis result. It will avoid quartz injector blast when the melt was in draft into the transfer tube. The injection speed, melt temperature, phosphorus excess, and so on are also important for a successful synthesis process. About 4-6Kg high purity, stoichiometric poly InP is synthesized reproducibly by improved transfer tubes P-injection method in the high-pressure puller in nearly 60-70 minutes. The obtained high mobility and low background concentration as measured from van der Pauw method implies the electrical quality of the synthesized material. Glow discharge mass spectroscopy (GDMS) results confirmed the low background levels of impurities.

Keywords: indium phosphide, growth from melt, liquid encapsulated Czochralski method

### P16.06.40

*Acta Cryst. (2008). A64, C591-592*

#### Initial state of VLS-growth of InAs nanorods on GaAs(111), probed by X-ray diffraction and TEM

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P16