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Review Article

A Review on Studies and Research on Crystallization

Sunil J. Kulkarni

Datta Meghe College of Engineering, Airoli, Navi Mumbai, Maharashtra, India

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ABSTRACT

Crystallization is a chemical solid–liquid separation technique. In this, mass transfer of a solute from the liquid solution to a pure solid crystalline phase occurs. For crystallization, supersaturation and temperature are two important factors. Crystallization finds major application in food and pharmaceutical industry. Silicon crystal wafer production, powder salt for food, production of sucrose from sugar beet is few industrial applications. Many investigators have carried out research on crystal size, growth and structure, factor affecting crystal growth and other important aspects of crystallization. The present paper summarizes research carried out on various aspects of crystallization

Key words: supersaturation, temperature crystal growth, morphology.

INTRODUCTION

The mass transfer operations are divided based on the state of the material. These classes of mass transfer are solid liquid, solid gas, liquid gas, liquid liquid, gas gas and solid solid. The liquid gas applications include gas absorption, humidification. Extraction is example of liquid liquid operation. These two categories are most important and find wide application. Adsorption is solid liquid and solid gas separation. These mass transfer operations find wide application in chemical industries and wastewater treatment. [1-5] For recovery and regeneration also these unit operations are important. In waste gas treatment absorption and adsorption methods are widely used. [6-8] Crystallization is solid liquid separation based on supersaturation of solution. The solution is supersaturated by evaporation or cooling or combination of both. The pharmaceutical and food industries find wide application of crystallization. Various investigators have carried out investigation on various aspects of crystallization. The current review summarizes research carried out on crystallization.

RESEARCH AND STUDIES ON CRYSTALLIZATION

Wellen carried out investigation on effect of polystyrene on poly (Ethylene Terephthalate) crystallization. [9] He compounded blends of poly (ethylene terephthalate) (PET) and polystyrene (PS) with PS content ranging from 0% to 60% by weight in a laboratory internal mixer, followed by quenching into iced water. Scanning electron microscopy (SEM) was used for analysis of blend morphology. He observed that SEM micrographs showed a

two-phase structure made up with spherical PS particles dispersed in a PET matrix. It was also found that crystallization of PET was affected by the heating rate and by the addition of even small amounts of PS. Pisponen et.al. investigated morphological parameters of lactose crystals during crystallization at low temperatures, using rapid and extra rapid cooling. [10] They carried out studies on three temperatures (2, 6 and 12°C) for crystallization of lactose. They used pure lactose for reference in their studies. They observed that Ricotta whey components reduce crystal size, and linked with low crystallization temperature; modify the shape of crystals faces. Chung and Ryu analyzed the effect of the addition of Li_2O_3, TiO_2, and Fe_2O_3 on the crystallization behavior of P_2O_5–CaO–SiO_2–K_2O glasses and the effect of the crystallization behavior on the roughness and hydrophobicity of the coated surface. [11] Their investigations confirmed that the intensity of the diffraction peaks increases at high temperatures and with increasing Li_2O_3 content. It was also observed that the increase in surface roughness, correlated to the crystallization of the glass frit, increases hydrophobicity of the surface. Newman et.al. carried out an investigation in order to combine sparse-matrix screening with systematic screening in a minimum number of crystallization conditions. [12] They tried to maximize the coverage of crystallization parameter space with no redundancy. They combined the screening strategy with nanolitre-volume dispensing hardware along with a small but practical experiment-tracking system. An investigation was carried out by her and Chen, aimed at studying the crystallization kinetics of ultrathin a-Si induced by Al under thermal annealing and pulsed laser irradiation. [13] They observed that, under thermal annealing, the crystallization temperature and activation energy for crystallization of a-Si with a thin Al metal layer reduced to around 340°C and 3.3 eV, respectively. McMahon et.al. purified and crystallized Ranasmurfin, a previously uncharacterized _13 kDa blue protein found in the nests of the frog polypedates leucomystax. [14] The analysis indicated the presence of a dimer in the asymmetric unit. In the fluorescent scan they observed a peak at 9.676 keV, indicating that the protein binds zinc and suggesting a route for structure solution.

Lawton et.al. carried out an investigation on the continuous crystallization of a model active pharmaceutical ingredient (API)using a continuous oscillatory baffled crystallizer (COBC). [15] According to their investigation, continuous crystallization offered significant advantages in terms of process, operation and costs. It delivered the isolation of the model API in just over 12 min compared to the 9 h and 40 min in a batch process. Rupp et.al. carried out an investigation on crystallization of amorphous ceria solid solutions. [16] Their studies were aimed at correlating the self-limited grain growth kinetics in ceria solid solutions with the microstructural evolution during the transformation of the amorphous state to the fully crystallized state. They found that, in the micrographs, grains with a globular shape without any preferred orientation as well as amorphous materials were visible after spray pyrolysis deposition and crystallization by heat treatment. An investigation was carried out on crystallization of biological macromolecules by Smatanova. [17] His studies were mainly focused on properties and crystal structures of proteins. He used stereomicroscope for the examination of the crystallization trials. Prasad and Srilalitha carried out research on crystallization process of $Fe_{78}Tm_2B_{20}$ and $Fe_{76}Tm_4B_{20}$ alloys. [18] The SEM patterns indicated that cast samples are amorphous and the samples are completely crystallized

when heated to 1000^0C. Kaldybayeva studied aluminums cast iron crystallization. [19] He studied the composition and structure of high-alloyed aluminum cast iron. He applied High-alloyed materials as the heat-resistant materials. According to him in present time, ability of the aluminum cast iron is being not used sufficiently. Heeley et.al. carried out an investigation on morphology and crystallization kinetics of polyethylene/long alkyl-chain substituted polyhedral oligomeric silsesquioxanes (poss) nanocomposite blends. [20] They blended POSS molecules with long linear alkyl-chain substituent. To elucidate the effect that POSS and its substituent groups have on the dispersal and crystallization kinetics of the host polymer, they used time-resolved small- and wide-angle x-Ray scattering (SAXS/WAXS) and thermal techniques. They observed that the miscibility and dispersal of the POSS molecules increased with the increasing alkyl-chain length substituent.

CONCLUSION

Crystallization is affected by heating and cooling rates. Also very small amount of impurity can bring about change in the crystallization. Also increase in surface roughness increases hydrophobicity. The analysis can be carried out by scanning electron microscopy and energy dispersed X ray. It was also observed that temperature and addition of impurities are important factors in crystallization.

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