

Towards quantification of crystal quality in self-assembly of processes

W. Khunsin¹, A. Amann^{1*}, G. Kocher^{1,2}, S. G. Romanov^{1,3}, S. Pullteap⁴, H. C. Seat⁴,
E. P. O'Reilly¹, R. Zentel⁵ and C. M. Sotomayor Torres^{1,6}

1. Tyndall National Institute, Lee Maltings, Cork, Ireland
2. School of Engineering and Physical Science, Heriot-Watt University, Edinburgh EH14 4AS, UK
3. Ioffe Physical Technical Institute, 194021, Polytekhnicheskaya ul., 26, St. Petersburg, Russia
4. Laboratoire d'Optoelectronique pour les Systemes Embarques, ENSEEIHT-INPT, Toulouse Cedex7, France
5. Institut für Organische Chemie, Johannes Gutenberg Universität, D-55099 Mainz
6. Catalan Institute of Nanotechnology and Research Centre for Nanoscience and Nanotechnology (CSIC), Campus Universitat Autònoma de Barcelona, 08193 Bellaterra, and Institute for Research and Advanced Studies, ICREA, 08010 Barcelona, Spain.

In this talk we will discuss self-assembly of nanostructures and approaches to quantify order. Self-assembly is an alternative and highly versatile approach to nanofabrication. However, perfect crystallographic order in the plane is seldom the outcome of a process relying on several interactions. Here we present a way to obtain crystal ordering in the plane and in the bulk by applying acoustic fields during vertical drawing crystallisation of colloidal mesoscopic and nanoparticles. This spatially coherence resonance-like behaviour in the self-assembly of three-dimensional fcc colloidal crystals results in an improvement of a factor of 10 of the in-plane crystallinity. The process is akin to stochastic resonance. The quantitative analysis is a generic approach to quantify crystal ordering using discrete Fourier Transform analysis of the scanning electron micrograph or AFM images. This approach can be extended to ascertain the degree of ordering of other self-organised structures, such as micelles or self-organised quantum dots. Our study covered also 3-dimensional order of these structures by optical transmission spectroscopy methods. We thus have tested a quantitative approach to self-assembly characterisation thereby bring it closer to metrics and standards, which are a prerequisite for uptake in future applications.

1. A Amann, W Khunsin, G Kocher, C M Sotomayor Torres and E P O'Reilly, *Stochastic Resonances in photonic crystal growth*, Proc. SPIE Vol. **6603** (Noise and Fluctuations in Photonics, Quantum Optics, and Communications, Ed. L Cohen), 660321 (2007)
2. W. Khunsin, S. G. Romanov and C. M. Sotomayor Torres, *Rotational symmetry of transmission patterns and ordering of opal photonic crystals*, J. Nonlinear Optical. Physics and Materials **17** (1) 97-104 (2008).
3. W. Khunsin, G. Kocher, S. G. Romanov, C. M. Sotomayor Torres, *Quantitative Analysis of Lattice ordering in thin-film opal-based photonic crystals*, Advanced Functional Materials **18** (17) 2471-2479 (2008).