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大阪電気通信大学学術研究教育国際交流助成基金
協賛　エレクトロニクス基礎研究所

講演会のご案内

大阪電気通信大学学術研究教育国際交流助成基金及びエレクトロニクス基礎研究所では、The 18th International Conference of Crystal Growth and Epitaxy (ICCGE-18, Nagoya, August 7-12, 2016) に参加されるために来日した Tonchev 先生をお招きして結晶表面に発生する step bunching 現象に関する講演会を開催します。卒研生・院生を含めて、多くの皆様の来聴を歓迎します。

日時：2016 年 8 月 3 日（水）14：00 より（1 時間半程度）
場所：エレクトロニクス基礎研究所新棟 2 階会議室（寝屋川キャンパス W 号館、W204 室）
講師：Vesselin Dimitrov Tonchev 准教授
（Rostislaw Kaischew Institute of Physical Chemistry, Sofia, Bulgaria）
題目： **Diffusion-limited (DL) vs. kinetics-limited (KL) crystal growth and instabilities**

Abstract

In the introductory part of the talk, the transition from DL- to KL-regime is illustrated using a 2D model based on Cellular Automata (CA). In it, similarly to the model of diffusion-limited aggregation (DLA), the growth starts from a seed but, differently from the DLA, proceeds by applying the automaton rule to all lattice sites in parallel with all particles spread on the lattice from the beginning and their number not sustained further ("batch crystallization mode"). The time is measured in parallel growth updates and between two consecutive ones, n_{DS} diffusional updates are performed that include only the single particles but not those belonging already to the crystal aggregate. When $n_{DS} = 1$ the growth is DL with fractal dimension of the aggregates ~1.68, but with increasing n_{DS} smoothly the fractal dimension of the aggregates also increases [1] to reach ~2 for n_{DS} of ~200.
In the main part are presented models of unstable vicinal crystal growth. In particular, they resolve the long-standing controversy between numerical results on the minimal step-step distance l_{min} in bunches and predictions of continuum theory - while the size-scaling exponent of l_{min} is found the same in diffusion-limited (DL) and kinetics-limited (KL) regime, and the time-scaling exponent of the bunch size N is predicted also to be the same (=1/2), the scaling exponents of the bunch width W and l_{min} are predicted to distinguish in between. With extensive calculations on the model of Sato and Uwaha (SU) we solve the puzzle. Results from other models are discussed as well: vicinal Cellular Automata (vicCA) [2], strain-induced step bunching [3], etc. Especially, for the vicCA it is the time-scaling exponent of the macrostep size N_m that makes the difference.
In the concluding part is introduced a simplest analytical model of crystal growth – that of N equally-sized crystals growing in batch crystallization mode independently of the others and in DL-regime at the same growth rate thus remaining with the same linear size. The considerations employ conservation law and kinetic equation and result in obtaining the universal curve of the model in the rescaled coordinates (Time, Supersaturation, Size) [4]. Further, the possible transitions between kinetic regimes, quantified by the power g with which the supersaturation enters into the

expression for the normal growth rate of the crystal are considered [5].

[1] D Goranova, R Rashkov, G Avdeev, V Tonchev, J. Mat. Sci **51**, (2016) 8663.

[2] F Krzyżewski, M Załuska-Kotur, A Krasteva, H Popova, V Tonchev, arXiv:1601.07371.

[3] A Krasteva, H Popova, N Akutsu, V Tonchev, AIP Conference Proceedings **1722**, (2016) 220015.

[4] C.Nanev, V.Tonchev, F.Hodzhaoglu, J. Cryst. Growth **375**, (2013) 10.

[5] V. Tonchev, G. As. Georgiev, P. Vekilov, C. Nanev, prepared for publication.

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