17th International Conference of Surfaces, Coatings
and Nanostructured Material | **NANOSMAT2026**
RHODES-GREECE | 6-10 JULY 2026
www.nanosmat.org

ABSTRACT:

Comparative Analysis of Nanostructures Formation in Semiconductors by Laser Irradiation and Stranski-Krastanov Methods

A. Medvids
Riga Technical University, P. Valdena Str.7, Riga, Latvia

Nanostructures (NSs) are the most investigated objects in solid-state physics, especially the Quantum confinement effect (QCE) in quantum dots – 0D, quantum wires - 1D, and quantum wells – 2D systems. The high interest in the subject is because, under these conditions, a change in the band structure of a semiconductor takes place. This leads to a crucial change in the physical properties of a semiconductor, leading to new possibilities for constructing electronic and optical devices [1]. Today, the commonly used methods for NSs formation are molecular beam epitaxy [2], ion implantation [3], chemical vapor deposition [4], sol-gel [5], spray-pyrolysis [6], magnetron sputtering [7], and laser ablation [8] with the following thermal annealing Stranski-Krastanov method [9]. By these methods, NSs mostly grow in a random manner, and the parameters of such structures are non-controllable. This impedes the development of nanotechnology.

Twenty years ago, we found a new quantum system, the so-called Quantum cone on the surface of a Ge crystal, which formed as a result of irradiation by Nd:YAG laser [10]. Later on, we observed the same phenomenon in Si [11], GaAs, CdZnTe single crystals, and SiGe solid solution, which possesses unique optical properties: a huge "blue shift" of photoluminescence (PL) spectrum, high intensity of PL, and "redshift" of LO phonon line frequency in Raman spectrum. Irradiation of Si crystal by Nd:YAG laser has led to the formation of nano cones which possess a unique PL spectrum: "blue shift" on 1.1 eV, an asymmetric, wide PL band of rainbow-like spectrum. Moreover, metallic Zn nanostructures arise on ZnO crystal after irradiation by the laser [12]. Advantages of the Laser irradiation method, compared to the Stranski-Krastanov method, include the ability to control the position and height of the cones via laser intensity and dose. Another major benefit is the possibility of using homogeneous materials to form nanostructures, which greatly expands the range of available materials and structures. Moreover, the laser irradiation method has a low economic cost: there is no need for a vacuum or special gas, and the process time is radically shorter.

[1] A. Medvids, P. Ščajev, K. Hara, Nanomaterials, 14, 1580 (2024).
[2] A. B. Talochkin, S. A. Teys, & S. P.Suprun, Phys. Rev. B 72, 115416 (2005).
[3] K.Giri, R.Kesavamoorthy, S.Bhattacharya. Materials Science and Engineering.B128, 201 (2006).
[4] J.M.Hartmann, F.Bertin, G.Rolland, M.N.Semeria. Thin Solid Films, 479, 113 (2005).
[5] M. Omid-Bakhtiari, N.Branch. Journal of Materials Engineering and Performance, 23, 285(2014).

[6] C. Ma, D. Moore, Y. Ding, J. Li, Z. Lin Wang. Int. J. Nanotechnology, 1,431 (2004).
[7] R. Behrisch, ed. Sputtering by Particle Bombardment. (Berlin: Springer) (1981).
[8] A. M. Morales & C.M. Lieber. Science, 279, 208 (1998).
[9] I. Stranski, L. Krastanov, Akademie der Wissenschaften Wien. 146: 797(1938).
[10] A. Medvid', Y. Fukuda, A. Michko, P. Onufrievs, Applied Surface Science, 244, 120 (2005).
[11] A. Medvid', I. Dmitruk, P. Onufrijevs, I. Pundyk. Diffusion and Defect Data Pt. B: Solid State Phenomena, 131, 559 (2008).
[12] A.Medvids, P.Onufrijevs, H.Mimura, V.Yukhymchuk. Physica Status Solidi C, 14,1700038 (2017).