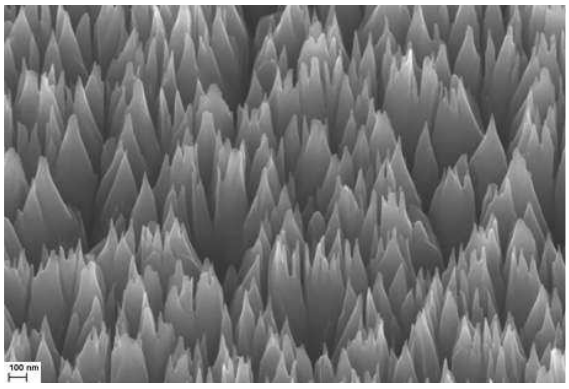
Thesis proposal

Lab: ESYCOM - Localisation: Université Paris-Est (ESIEE Paris & UMLV)
Groups: Microcomponents et Nanotechnology / Electromagnetism

Nanostructured materials for environmental monitoring sensors

Since several years; the study and protection of the environment has become a central aspect of public policy; and has generated enormous interest among both environmental groups and industrial players. A very strong need exists for low-cost sensors capable of environmental monitoring, and particularly of analyzing the chemical composition of the atmosphere and determining the air quality. Many such sensors rely on traditional optical absorption techniques, which are typically performed in the near infrared (near-IR) and IR spectrum. The element which determines both the cost and the accuracy of such a system is the sensing unit, and hence a lot of attention has been given to developing novel materials for IR sensors.

Among the materials that have seen recent interest, black silicon stands out as a particularly tunable nanostructured material [1]. Depending on the fabrication process parameters and on the initial state of the substrate, the topography of the structures that can be created on the surface of silicon can vary widely over the range 100 nm - 10 um. This creates a variety of different materials characteristics, in particular related to interactions with electromagnetic waves (optical absorption). Our on-going work is focused on the fabrication of optical sensors based on black silicon, including detailed simulations of the interactions of electromagnetic waves with the surface nano-topography [2].



Black silicon fabricated at Université Paris-Est / ESIEE Paris

The subject of this thesis is twofold: on one hand, the successful candidate will study different nanostructured black silicon surfaces, including accurate determination of surface topography and of associated optical reflection spectra; the study will also entail the development of image analysis software which will be used to reconstruct 3-D models of the surfaces from microscopy data. On the other hand, the candidate will then use the resulting 3D model to perform modelling and simulations of electromagnetic reflection. The electromagnetic modelling results will in turn be used to optimize the characteristics of the material: As an application; the candidate will develop a complete optical sensor based on black silicon and will benchmark it against existing competing technologies.

The succesful candidate will be part of a young, dynamic, multidisciplinary team. He should have a strong background in Materials Science, Physics or Engineering, demonstrate good laboratory skills and have good programming capabilities.

Interested students should send their CV Prof. Dan Angelescu (d.angelescu@esiee.fr), Prof. Elodie Richalot (Elodie.Richalot@univ-mlv.fr) and to Prof. Philippe Basset (p.basset@esiee.fr).

1. R. Younkin, J. E. Carey, E. Mazura, J. A. Levinson and C. M. Friend, "Infrared absorption by conical silicon microstructures made in a variety of background gases using femtosecond-laser pulses", *Journal of Applied Physics*, vol. 93, no. 5, pp. 2626-2629.

2. K. N. Nguyen, D. Abi-Saab, P. Basset, E. Richalot, F. Marty, D. Angelescu, Y. Leprince-Wang, T. Bourouina, "Black silicon with sub-percent reflectivity: influence of the 3D texturization geometry", *Proceeding of the 16th int. Conf. on Solid-State Sensors, Actuators and Microsystems (Transducers'11)*, Beijing, China, 2011