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Digital etching of III-V semiconductors in aqueous solutions

Etching of semiconducting materials at rates approaching atomic level resolution is of high interest to the advancement of technologies addressing fabrication of low-dimensional devices, tunability of their optoelectronic properties and precise control of device surface structure. The so- called digital etching that takes advantage of a self-limiting reaction has the potential to address some of these challenges. However, conventional applications of this approach proposed almost 30 years ago, require specialized and expensive equipment, which contributed to a relatively slow progress in penetration of digital etching to micro/nanofabrication processing schemes. We have observed that for photoluminescence (PL) emitting materials with negligible dark corrosion, it is possible to carry out PL-monitored photo-corrosion in cycles analogous to those employed in digital etching. The advantage of this approach is that photo-corrosion of materials, such as GaAs/AlGaAs hetero-structures, could be carried in a water environment. This digital photo-corrosion (DIP) process could be carried out in cycles, each approaching sub-monolayer precision. I will discuss fundamentals of DIP and mechanisms responsible for achieving high-resolution etch rates of semiconducting materials. For instance, we have demonstrated a successful dissolution of a 1-nm thick layer of GaAs embedded between $Al_{0.35}Ga_{0.65}As$ barriers in a 28% NH_4OHH_2O, and we claimed that under optimized conditions a further enhanced resolution is feasible. The nm-scale depth resolution achieved with DIP and low-cost of the instrumentation required by this process is of a potential interest to specialized diagnostics, structural analysis of multilayer nanostructures and, e.g., revealing *in-situ* selected interfaces required for the fabrication of advanced nano-architectures. We have explored the sensitivity of DIP to perturbations induced by electrically charged molecules, such as bacteria, immobilized on semiconductor surfaces. Here, I will highlight our recent studies on detection of *Escherichia coli* and *Legionella pneumophila* bacteria immobilized on antibody functionalized GaAs/AlGaAs biochips. I will also discuss the application of this approach for studying antibiotic reactions of bacteria growing on biofunctionalized surfaces of GaAs/AlGaAs biochips.

Biography

Jan J Dubowski received his PhD degree in Semiconductor Physics from the Wroclaw University of Technology, Poland. He is a Canada Research Chair and a full Professor at the Department of Electrical and Computer Engineering of the University de Sherbrooke, Canada. He is a Fellow of SPIE- The International Society for Optics and Photonics (citation: “For innovative methods of investigation of laser- matter interaction”). He has published over 200 research papers, reviews, book chapters and conference proceedings. He is an Associate Editor of the *Journal of Laser Micro/Nanoengineering, Biosensors and Light: Science & Applications.*

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