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International Conference on

Nanomaterials and Nanochemistry

November 29-30, 2017 | Atlanta, USA

Technology of nanofabrication of GaN-based substrates for surface enhanced Raman spectroscopy measurements: Chase for hot-spots

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It is commonly accepted that the presence of so-called hot-spots is necessary for obtaining high enhancement factor (EF) of Raman signal from individual molecules attached to the plasmonic metal particles. The hot-spots contribute most significantly to the overall SERS intensity. Two approaches are usually used in order to deliver SERS platforms, namely planar and nano-structured substrates, both with plasmonic metal particles on the top surface. The aim of this presentation is to review the new technology of nano-structuring of hetero-epitaxial GaN layers. The nano-structures are formed using galvanic, electroless and orthodox etching methods. The principles of etching methods, commonly used for revealing and analysis of crystallographic and electrically active defects, will be discussed. As a result of studying defects in hetero-epitaxial GaN, the nano-structured hetero-epitaxial GaN surfaces appeared to be suitable for SERS measurements. It will be shown that the dislocation-related nano-pillars and pits (formed during electroless and orthodox etching, respectively) are responsible for formation of hot-spots and the increased EF. Tailoring of plasmonic metal layers sputtered on etched GaN surfaces for increased SERS efficiency using dealloying and annealing will be also addressed. The novel SERS platforms based on etched GaN show very good mechanical and chemical stability and high EF up to 10^6 for the examined molecules of para-mercaptobenzoic acid (pMBA) and pyridine. This feature enables also time-lapse measurements of various biological systems such as Hepatitis B virus antigen and different bacteria (BC, BT, BS).

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