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Two-Dimensional Metallo-Semiconductor Networks for Electronic and Photonic Applications

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Two-dimensional metallo-semiconductor networks have been fabricated by pulsed electrochemical deposition of Pt inside porous GaP membranes with parallel pores possessing diameters in the micrometer and sub-micrometer ranges. The electrochemical parameters were optimized for a uniform metal deposition on the inner surface of the pores. This technology was applied for the fabrication of a variable capacitance device on the basis of Pt/GaP Schottky diodes formed on Pt/GaP interpenetrating networks. The capacitance density variation caused by the change in voltage applied to this device is much higher than that inherent to standard devices. Taking into account the quasi-ordered spatial distribution of pores in the GaP template, one can assume that the produced 2D metallo-semiconductor networks are promising also for specific photonic applications.

Introduction

2D metallo-semiconductor interpenetrating networks are promising for various applications, in particular in photonic elements based on negative refractive index metamaterials, sensors involving barrier structures and plasmonic excitations, memory media based on magnetic nanostructures embedded in semiconductor matrices, etc. For the purpose of comparison one can note that one-dimensional metallo-dielectric multilayer structures prove to be transparent in specific spectral regions and exhibit negative refraction and subwavelength imaging (1,2). Recently we have shown analytically that metallized titania nanotubes are promising for designing and manufacturing negative refractive index materials (3). Flat and concave lenses assembled from these nanotubes demonstrate good focusing properties at specific photon energies which are determined by the geometry of nanotubes. The prospects for the elaboration of photonic crystal lenses and beam splitters on the basis of two-dimensional metallo-semiconductor structures have been recently demonstrated on Pt-ZnSe nanocomposite (4). From the point of view of nanoelectronics and optoelectronics, metal nanowires and nanotubes are attractive materials because of their unique properties suitable for a variety of applications. In nanoelectronic devices, nanowires are used as interconnects, magnetic structures, chemical and biological sensors. The optoelectronic applications of metal nanowires and nanotubes are based on the extended dielectric/metal interface that can