SURFACE PLASMON RESONANCE IN Ag NANOPARTICLES DEPOSITED INSIDE POROUS GaP TEMPLATES

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Abstract–*Surface plasmon resonance is studied for Ag nanoparticles electrochemically deposited on bulk GaP substrates and inside porous GaP templates. The size and density of Ag nanoparticles are controlled by the conditions of electrochemical deposition and thermal processing. The experimental data are analyzed in the frame of the Drude theory taking into account the parameters of the metallic nanoparticles and the morphology of the porous template. It is shown that porous templates provide wide possibilities for the control of the surface plasmon resonance frequency.*

Keywords: *Surface plasmon resonance, Ag nanoparticles, porous GaP templates, Drude theory, reflectance spectroscopy.*

1. INTRODUCTION

Today's information technologies are driven by electronics and photonics which use electrons and photons, respectively, to carry, store, and process information. An emerging branch of photonics, called "plasmonics", aims at using nanostructured materials that support "surface plasmons" for these purposes. Plasmonics can potentially achieve highly complex miniaturized devices by controlling and manipulating light on the nanometer scale [1, 2]. Metal nanostructures can exhibit strong local resonances of light-induced electron plasma oscillations. Due to such resonances the electromagnetic field intensity close to the surface of the nanostructures can be strongly enhanced. These electromagnetic fields lead to fascinating enhancement of optical characteristics such as surface-enhanced resonant Raman scattering [3], enhanced transmission through subwavelength apertures [4], enhanced non-linear optical properties [5], etc. The main contribution to this enhancement arises from the excitation of localized surface plasmons (LSP) [3]. Porous semiconductor templates offer possibility for a wide variation of the effective refractive index by tailoring the morphology and porosity of the template, and consequently for the control of the plasmon resonance in metallic nanoparticles deposited inside the template.

In this work we investigate the influence of the porous semiconductor template on the plasmon resonance frequency of Ag nanoparticles as compared to bulk semiconductor template.

2. EXPERIMENTAL

(111)-oriented n-GaP:S wafers with electron concentration 10^{18} cm^{-3} cut from Czochralsky-grown ingots were used for the fabrication of porous GaP layers. The anodic etching was carried out in a double-chamber electrochemical cell with 4 electrodes as described elsewhere [6]. Electrochemical treatment carried out with the applied voltage of 25 V in a H_2O:HCl:H_2SO_4 (50:5:20 volume parts) solution at 50 ^oC during10 minutes results in the formation of a template with the morphology illustrated in Fig. 1

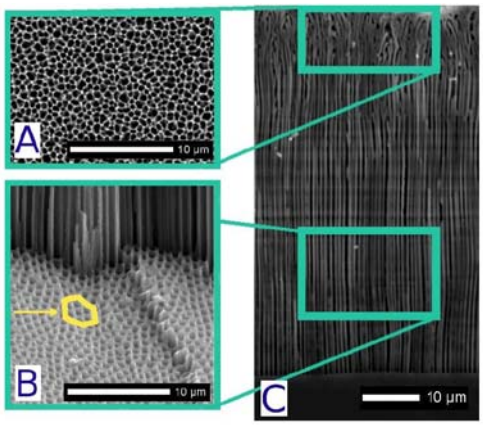

Fig. 1. SEM image of a GaP template taken at the surface (A), in the volume (B) and cross section (C).