MICRO- AND NANO-ENGINEERING OF SEMICONDUCTOR COMPOUNDS AND METAL STRUCTURES BASED ON ELECTROCHEMICAL TECHNOLOGIES

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Abstract. This paper aims to address the challenges of micro- and nano-engineering semiconductor compounds and fabricating metal-semiconductor nanocomposite materials by developing theoretical concepts for the application of electrochemical nanostructuring technologies to semiconductor substrates. It includes identifying the technological conditions for controlled electrochemical etching to create nanostructured semiconductor templates with wide bandgaps, such as III-V semiconductors (InP, GaAs, GaN) and II-VI compounds (CdSe, ZnSe, $Zn_xCd_{1-x}S$). The study also demonstrates the conditions for electrochemical metal deposition in porous semiconductor templates and investigates the laws and mechanisms of metal deposition depending on the composition of the semiconductor substrates and current pulse parameters. Additionally, the paper addresses the conditions for electrochemical etching of semiconductor substrates to produce nanowire networks with directed alignment to the substrate surface, instead of merely producing porous layers. A comprehensive investigation of the properties of the developed nanostructures and materials is proposed to demonstrate their applicability in nanoelectronic, optoelectronic, and photonic devices.

Keywords: Wide bandgap semiconductors, Crystallographically oriented pores, Current line oriented pores, Pore growth direction, Hopping electrodeposition, Anomalous retroreflection, IR photodetector, Integrated photonic lenses, Magnetic anisotropy, Hybrid core-shell structures, Hydrophilic/hydrophobic properties, Varicap.

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1. Introduction. Motivation of the study

Starting with the rapid development of nanotechnology in the 1990s, a wide range of porous materials were developed. The discovery of macroporous silicon by Lehmann and Föll over thirty years ago generated significant interest [1]. Nowadays, several well-studied self-ordered porous materials are used in various fields, including: (i) porous alumina developed by Masuda and Fukuda in 1995 [2];

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