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Title of the dissertation: Fabrication of gold, copper and titanium nanostructures obtained during thermal processing and their characteristics
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ABSTRACT

The PhD dissertation concerns the development of the fabrication procedure of bimetallic AuCu nanoparticles obtained on nanostructured titanium and titanium dioxide platform. Such electrodes act as material photoelectrochemically active under visible light illumination water splitting and alcohol oxidation processes finding future application in solar cells and fuel cells production. The materials were fabricated using electrochemical anodization of Ti foil, chemical etching, thin AuCu alloy, Au, Cu layers deposition in various configurations and thicknesses by means of magnetron sputtering as well as using rapid and gradual thermal treatment. The fabrication process of gold, copper and titanium nanostructures was optimized, especially the impact of different temperatures, rates, time and atmosphere (air, vacuum, argon and hydrogen) during thermal treatment on materials performance was investigated. Detailed characterization of morphology, optical and structural properties as well as electrochemical and photoelectrochemical activity in the presence of solar light simulator illumination was carried out. Based on experimental data correlation between size, shape, structure and chemical composition of gold and copper nanoparticles and their optical and electrochemical properties was determined. The theoretical part of this study discusses gold nanoparticles, discrete band states in nanoparticles, surface plasmon resonance, the p-type and n-type semiconductors on the example of copper oxides and titanium dioxide, doping of semiconductors by introduction of additional energy levels into their structure and mechanism of charge transfer at the p-n junction. Furthermore, detailed description of methods used for fabrication and then material characterization is presented and enriched with literature data on examples of materials discussed in thesis. The main result shown in this PhD thesis is the development of fabrication procedure of ordered Ti nanodimples and TiO_2 nanotubes platforms modified by AuCu nanoparticles which are characterized by increased absorption in visible light as well as enhanced photoactivity and catalytic activity. The data described here can contribute in fabrication of new functional nanomaterials active in processes of converting solar energy into electricity as well as more efficient solar and fuel cells in industry.