Laser-assisted fabrication of electrode materials for non-enzymatic sensors using deep eutectic solvents

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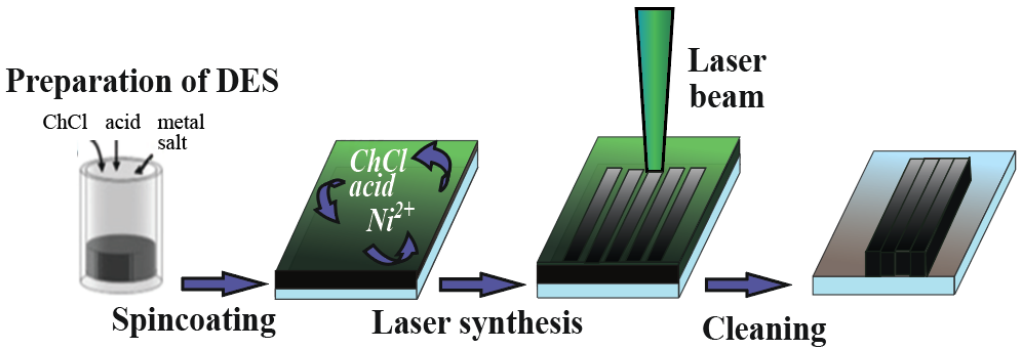
1. Introduction

In this work, we propose a technique for laser-induced deposition of nickel micropatterns from deep eutectic solvents (DES) on the surface of oxide glasses. Solutions of DES consisting of choline chloride, citric or tartaric acid, and nickel salts were used as solutions for precipitation, and the fundamental possibility of obtaining bimetallic and metal-carbon structures was also demonstrated. It is shown that irradiation with continuous laser radiation at a wavelength of 532 nm makes it possible to significantly increase the rate of metal deposition and create micropatterns with good electrochemical properties, as well as high adhesion to the surface, which makes it possible to use the synthesized patterns in practice, including for creating sensor platforms for electrochemical analysis.

2. Material and methods

In this work we used method of laser-induced chemical liquid-phase deposition of metals from solution (LCLD).

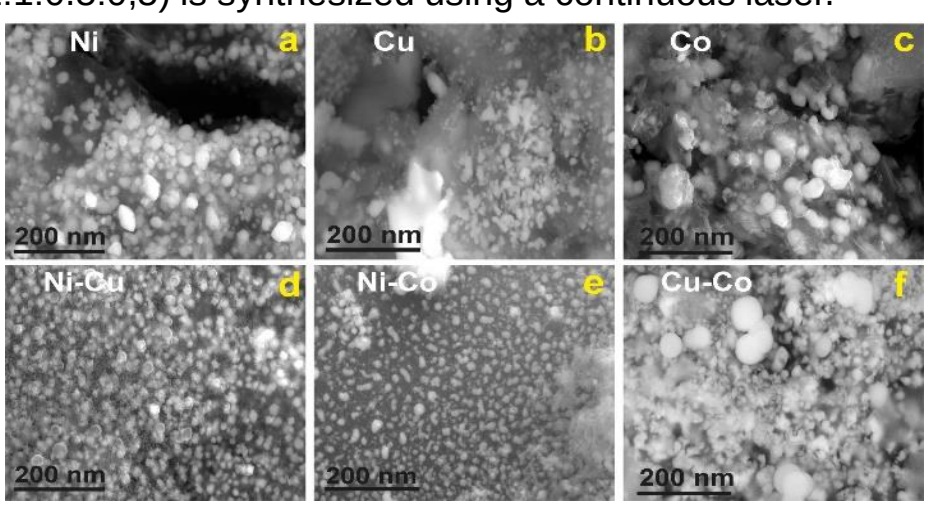


We performed the deposition of nickel on substrate with DES mounted in a vertical position using the experimental set-up with continuous wave 532 nm diode-pumped solid state Nd:YAG laser was used.The amount of the components used for preparation of DES was:

	Choline chloride (mmol)	Citric acid (mmol)	$NiCl_2 \times 6H_2O$ (mmol)	$Ni(OAc)_2 \times 4H_2O$ (mmol)
1	7	7	35	
2	7	7		35

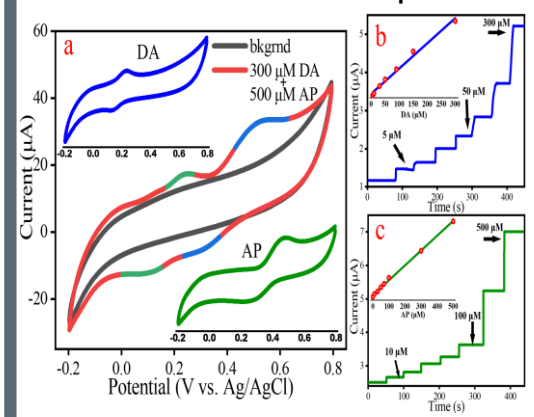
3. Results

In our previous works, it was demonstrated that LCLD can be successfully used to fabricate enzyme-free sensor platforms suitable for detection of various biologically important analytes. In the current studyof research was the synthesis of composite materials in DES; the fundamental possibility of obtaining structural bimetallic particles under the influence of laser radiation on the surface of oxide glass was noted. Such materials acquire characteristic features and significantly outperform individual components, since in many cases synergistic detection is observed when polymetallic enzyme-free enzymes are used. For the synthesis of bimetallic composites in a Ni-Co-Cu mixture, solvents with citric and tartaric acids based on chlorides and acetates of cobalt, copper and nickel are found (organic acid: choline chloride: metal salt1: metal salt2 1:1:0.5:0,5) is synthesized using a continuous laser.

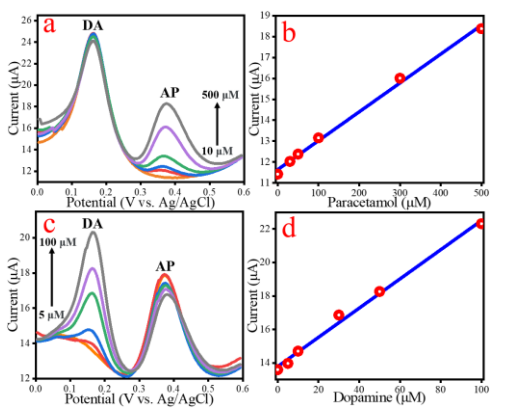


4. Electrochemical studies

Next, we investigated the primary electrocatalytic properties of the fabricated micropatterns.



Cyclic voltammograms (CVs) of Ni-based electrode recorded in solutions containing dopamine (blue) and acetaminophen (green) individually and as a mixture (red). The amperometric current of the fabricated Ni-based electrode recorded in the presence of different concentration of dopamine (b) and acetaminophen (c).



DPV of Ni electrode in solutions containing 300 mM DA and various amounts of AP. (c) DPV of solutions containing 300 mM of AP and various amounts of DA. The dependences of the analytical signal on the concentration of AP(b) and DA(d).

Synthesized nickel electrodes showed good electrochemical characteristics**: sensitivity - 122 and 88 μA mM^{-1} cm^{-2}, LODs - 0.11 and 0.34 μM**

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