NANOCRYSTALLINE DIAMOND LAYERS FOR ELECTROCHEMICAL AND BIOLOGICAL APPLICATIONS

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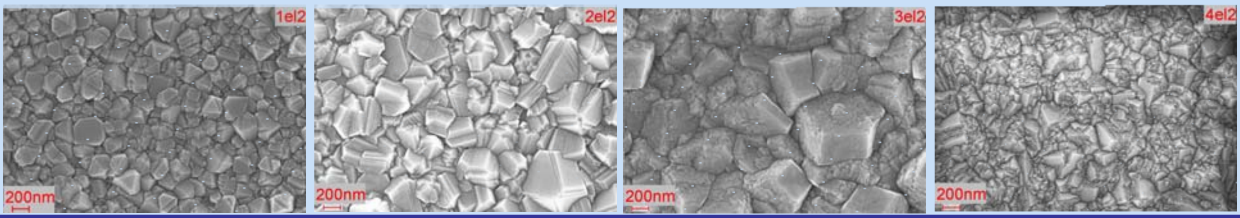
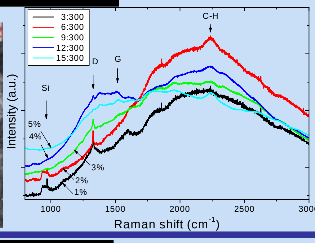
ABSTRACT

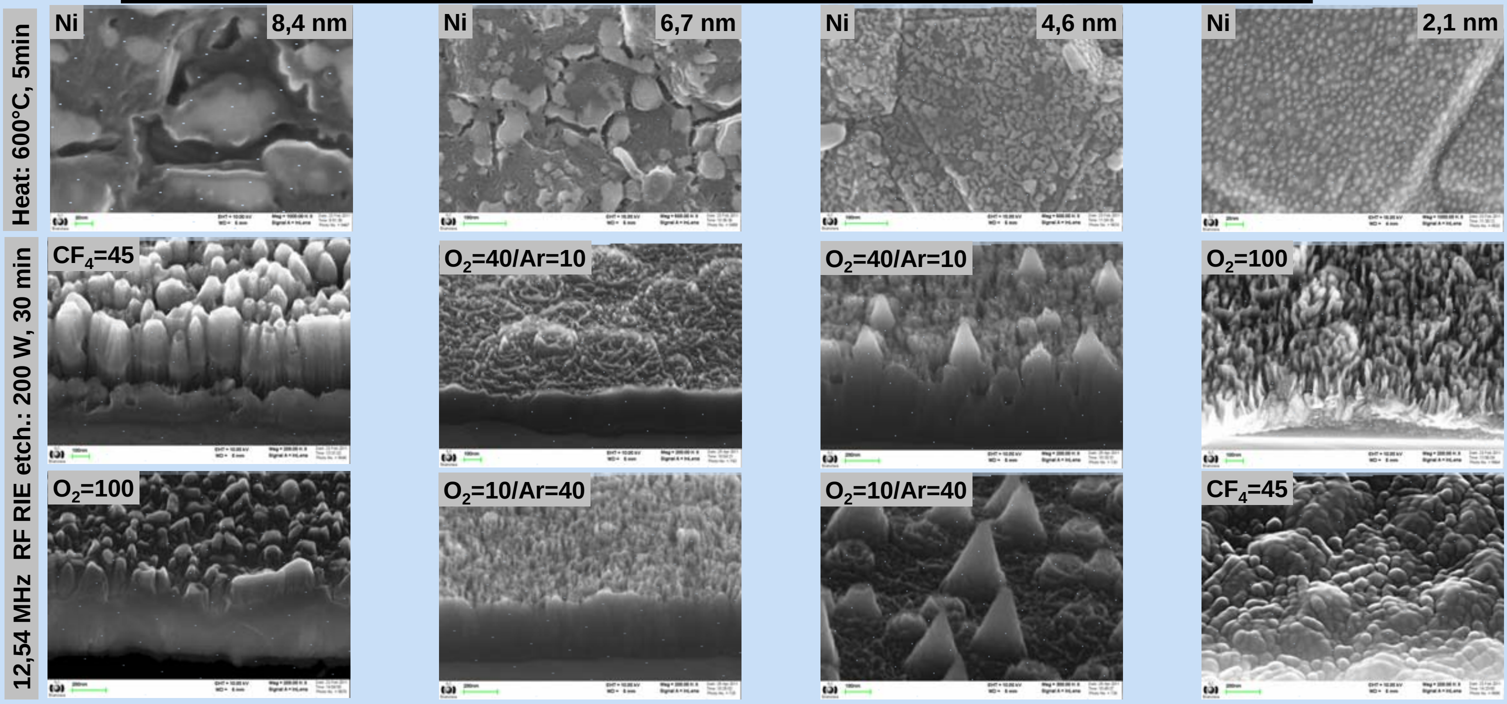
Detection of trace heavy metals in water and biological materials is not new topic, but there are several reasons for which this issue is brought to the forefront again. One of the most preferred reasons why we are dealing with trace heavy metals is the fact that it is necessary to replace existing mercury-film electrodes (MFE). However, because of mercury toxicity, future regulations and occupational health considerations may severely restrict the use of mercury. In search for alternative electrode materials, bismuth-film electrodes (BiFE) offer comparable performance to MFE for anodic stripping voltammetric measurements of trace metals, as it was shown. Stripping analysis has proved to be a powerful technique for the determination of trace heavy metals in various samples. Properties of NCD films include simple preparation, high sensitivity, excellent peak resolution, negligible toxicity and ability to operate in highly alkaline media. The choice of electrode material for detecting trace metals is very important. Carbon substrates such as glassy carbon, carbon paste, carbon fiber, diamond-like carbon (DLC), boron-doped diamond (BDD), carbon nanotubes, pyrolyzed photoresist, gold, platinum and others seems to be a good choice. In this paper we investigated properties of nanocrystalline diamond (NCD) as a substrate for in-situ bismuth electroplating electrode system and biological detection (DA-dopamine, UA-uric acid, AA-ascorbic acid). The composition and nanopatternig of NCD films has been analyzed by Raman spectroscopy and SEM .

Nanocrystalline diamond thin films

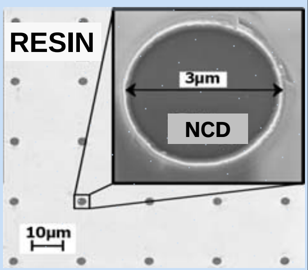




Nanopatterning of NCD thin films

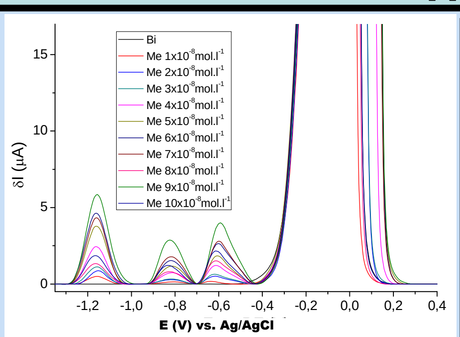


Sensor applications



Array: 1x1 cm^2, 50 625 pcs., Active: 0,375 mm^2,Si (100) N-type

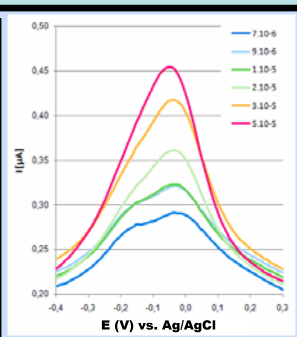
Trace metals

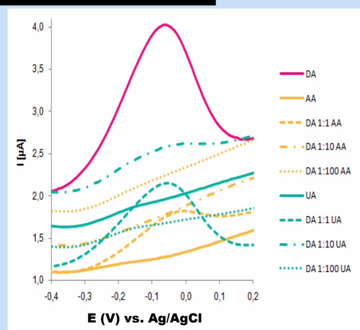


SWASV : Range: - 1.5-0.3 V, E_{step}= 5 mV, E_p= 0.1 V, Freq= 100 Hz, 0.1 M acetate buffer (pH 4.5), Bi=3x10^{-6} M, E_d : -1.3 V, t_d : 120 s

LOD$_{Zn}$= 1.0x10^{-8} M, LOD$_{Cd}$= 1.5x10^{-8} M, LOD$_{Pb}$= 1.3x10^{-8} M

Biological





DPVASV: -0.4 to 0.3, E_{step}= 9 mV, E_d:0.52 V, t_d=10 s, E_{mod}= 0.2 V, t_{pw}=5 ms, McIlvain (0.1 mol/l, pH 5)

LOD$_{DA}$= 1.3x10^{-9} M, R^2=0,98

DA= 1x10^{-4} M, AA= 1x10^{-4} M, UA=1x10^{-2}

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