PECVD of DLC & N-doped DLC Thin Films for Biomedical Applications

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We have deposited pure diamond-like carbon (DLC) and nitrogen (N)-doped DLC thin films by plasma enhanced chemical deposition (PECVD) method. For bio-medical application test, nickel (Ni) nano particles have been electro-deposited on nitrogen-doped diamond-like carbon (N-DLC) thin film surface at potentials ranging from -1.1 V to -1.4 V vs Ag/AgCl in 0.1 M Na_2SO_4 aqueous solution containing 4 mM $NiCl_2$. Atomic force microscopy has been used to investigate the growth of the nano particles. The mean growth rate of the particles increases while the nucleic density decreases when the deposition potential becomes more negative. There is a tendency to obtain large particles at more negative potentials. The growth kinetics has been studied with the dependence of potentiostatic current density on the deposition time, and the growth mechanism has been explained by the cyclic voltammogram of N-DLC film electrode in the deposition solution.

1. Introduction

Metal nano particles deposited on highly boron doped diamond (BDD) thin film electrodes have been studied for electro-analysis application [1] because of the large potential window and low background current and inert surface with BDD electrodes. Recently, there is effect to replace BDD electrodes with nitrogen doped diamond-like carbon (N-DLC) electrodes, which have many chemical and mechanical properties similar to those of BDD thin film electrodes and can be deposited under easier conditions and have smoother surface because of amorphous structure [2]. Previously the authors [3] have reported that the nickel nano particles on N-DLC film possess catalytic function for glucose oxidation which indicates the potential application for direct glucose sensing.

In this work, the deposition potential has been studied to control the nucleic density of nickel nano particles deposited on N-DLC film electrodes. This work is the first step to optimize nickel nano particles on N-DLC film for bio-medical sensing.

2. Experimental

The N-DLC film was cut into 1.2 cm×1.2 cm squares for nano particle deposition and electrochemical testing. An O-ring fixture with an exposed area of Φ 7 mm was designed to seal the N-DLC film squares to service as working electrodes, and a platinum plate was employed as the count electrode opposite to the working electrode. An Ag/AgCl electrode with saturated KCl aqueous solution was taken as the reference electrode. The 3-D morphology of the nano particles deposited at different potentials is presented in Fig.1 and compared with that of as-deposited N-DLC film surface. The surface of as-deposited N-DLC film is very smooth at atomic scale. The nano particles presents the shape of rods, and they are sharp (pine-like) at the deposition potential of -1.1 V, while they become dull (corn-like) when the deposition potential gets more negative. The nano particles deposited at -1.1 V looks like jungles, while the particles are distantly separated at the more negative potentials.

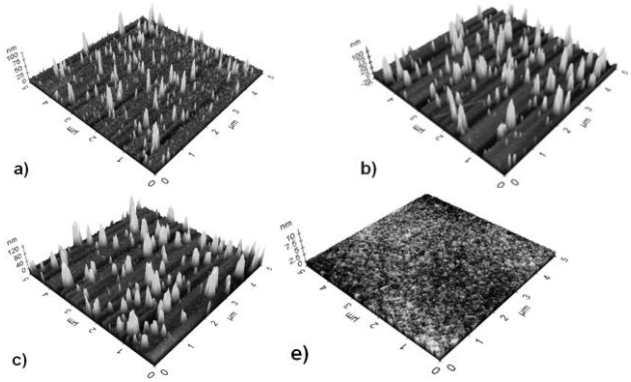

Fig. 1. 3-D AFM Images for the nickel nano particles deposited on N-DLC film surface dependent on the deposition potential: a) -1.1 V, b) -1.2 V, and c) -1.3 V, and compared with that for e) the as-deposited DLC film surface.

3. References

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