Microstructure of nickel nanoparticles embedded in carbon films: case study on annealing effect by micromorphology analysis

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Abstract

The presented study is aimed at analyzing the surface texture of amorphous hydrogenated carbon layers containing nickel nanoparticles (Ni-NPs@a-C:H) within their structure, which were deposited by Radio Frequency (RF) sputtering and RF-Plasma Enhanced Chemical Vapor Deposition (RF-PECVD) methods on glass substrates. Prepared films were then used as research material following their annealing at two different temperatures of 250 °C and 350 °C in an inert argon atmosphere. Series of height samples were taken with the help of atomic force microscopy (AFM) operating in a non-contact mode and examined in order to determine their fractal characteristics. Raw AFM data were first plane-fitted to remove the surface bow exhibiting the so-called residual surface, and then numerically processed to calculate the Areal Autocorrelation Function (AACF), which was later used to compute the Structure Function (SF). The log–log plots of the latter served for calculation of fractal properties of surfaces under investigation, including fractal dimension D, and pseudo-topothesy K. The analysis of 3-D surface texture helps to understand their essential characteristics and their implications as well as graphical models and their implementation in computer simulation.

Keywords: Ni NPs @ a-C: H thin films, RF-PECVD, AFM, Fractal analysis, 3-D surface texture.