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SCIENCE DIRECT

Surface & Coatings Technology 200 (2005) 297–300

www.elsevier.com/locate/surfcoat

The formation of low-dimensional structures by compressive plasma flows

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Available online 11 March 2005

Abstract

The process of the deposition of low-dimensional structures on the silicon surface exposed to the compression plasma flow has been studied. Scanning electron microscopy, transmission electron microscopy and Rutherford backscattering spectroscopy have been used to analyze the morphology, microstructure and elemental composition of the near-surface layer. The deposited coating consists of a spherical metal containing particles with a size of 50–200 nm. Possible mechanism of the coating formation is discussed.

PACS: 52.40.Hf; 52.77.Dq; 68.37.Hk; 81.20.Ev
Keywords: X Low-dimensional coating deposition; B Scanning electron microscopy; B Transmission electron microscopy; B Rutherford backscattering spectroscopy; C Pulsed plasma; D Silicon

1. Introduction

Nowadays, the formation of low-dimensional ordered structures on a semiconductors surface for the micro-, nano-, and optoelectronics application [1] is one of the main directions of the development of applied material science. Different ion-plasma treatment techniques can be used for the nanoscaled functional coating formation on a sample surface. A highly dispersed coating with a grain size of 2 nm was formed by spraying the material on a substrate with an intense ion beam [2]. A thin film consisting of Si nanoclusters with an average size of 25 nm was deposited on Si wafers by means of a pulsed-laser ablation technique [3].

The treatment by compression plasma flows is one of the most effective methods for the modification of materials near-surface layers [4–10]. It can be also used for the deposition of nanostructured coatings on a target surface. Compared to conventional ones, this technique offers a number of advantages, among them high plasma parameters (such as the velocity and density of plasma-forming particles in a wide range of values) and the possibility of alloying a surface layer by a plasma-forming substance or by a material intentionally introduced into a plasma flow. Furthermore, the treatment can be realized in an extremely short time ~100 μs.

The study of the structure, elemental, and phase composition of coatings obtained by exposing a target to compression plasma flows with the injection of nanoscaled metal particles into plasma was carried out in this work.

2. Experimental

Plasma flows used for the samples modification were generated by the magnetoplasma compressor (MPC) of compact geometry with the energy of the capacitor storage

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doi:10.1016/j.surfcoat.2005.02.007