NANOCONES ON (a-C:H):Si FILMS: BASIC CONDITIONS FOR PROCESSING AND OPTICAL PROPERTIES

V.D. Frolov[1], A.V. Khomich[2], V.V. Kononenko[1], V.A. Gerasimenko[1], S.M. Pimenov[1], G.G. Kirpilenko[3], V.I. Kovalev[2], E.Y. Shelukhin[3]

[1] A.M. Prokhorov General Physics Institute of RAS, 38 Vavilov str., Moscow, Russia

[2] Institute of Radiotechnics and Electronics of RAS, 1 Vvedensky sq., Fryazino 141190, Russia

[3] Patinor Coatings Ltd., NIIMV, Zelenograd, Moscow 103460, Russia

Contact e-mail: frolov@ran.gpi.ru

Amorphous (a-C:H):Si thin films attract great interest due to unique combination of mechanical, electrical, optical and thermal properties. Functional and technological opportunities of micro-electromechanical systems (MEMS) and optoelectronic systems (OES) can be broadened significantly with genesis of thermally stable resistive micro-heaters and emitters on the base of metal-containing (a-C:H):Si films [1]. Recently a new effect of Scanning Probe Microscopy (SPM) -based nanostructuring, namely the electric field–assisted growth of nanocones, was observed in metal-free (a-C:H):Si films [2]. The SPM process was found to be highly reproducible thus realizing nanocone arrays with a preassigned configuration.

In the present work, we report the inner properties (atomic content and structure, sp^2/sp^3 bond ratio, surface morphology and energy) and external conditions, in the presence of which the metal-free (a-C:H):Si films show ability for the nanocone growth. The experiments were done with the 50-200 nm thick (a-C:H):Si films, deposited on Si substrates by CVD method, where silicon-organic liquid was used as a plasma-forming substance of the open plasmatron. Under optimal conditions, the electric field-induced SPM actions on the film surface lead to the formation of nanocones up to 100 nm in height. Special emphasis is paid for optical parameters of the (a-C:H):Si films before and after the SPM actions. It is distinctive that for the untreated region the refraction index is n=2.15-2.2 (in the spectral range of 400 – 700 nm), and decreases to n~ 1.6 after the SPM-actions. In the same spectral range the extinction coefficient inside the modified region becomes close to zero. Raman spectra evidence about ordering the film atomic structure under the SPM actions.

Possible mechanism of the SPM-based nanostructuring is discussed.

The work was supported by the Russian Foundation for Basic Research, project no. 07-02–12090.

References:

[1] V.K. Dmitriev, V.N. Inkin, G.G. Kirpilenko, B.G. Potapov, E.A. Ilyichev, E.Y. Shelukhin, Diamond and Related Materials **10** (2001) 1007.
[2] G.G. Kirpilenko, E.Y. Shelukhin, V.D. Frolov, E.V. Zavedeev, S.M. Pimenov, Diamond and Related Materials **15** (2006) 1147.