Peculiarities of carbon nanofibres obtained by PECVD

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Carbon nanofibers production has several features in industrial facilities. One of the most important features is the cost of nanofibre. The use of PECVD (plasma enhanced CVD) is one of promising ways in the development of industrial and semi-industrial facilities, which allows use gaseous methane as cheap and clean source of carbon [1].

Well known that plasmochemical pyrolysis creates soot nanoparticles (25-50 nm in diameter) in air-methane plasma flow. Influence of these soot nanoparticles on the performance of PECVD facility and nanofibre properties is discussed in the report. It was shown that the thermophoretic deposition of soot nanoparticles on metal surface drastically increase the probability of the formation of carbon clusters in supersaturated solid solution near the metal interfacial surface [2]. As a result of coalescence of carbon clusters nanofibre diameter nearly equals to the diameter of the primary soot nanoparticle d. For majority cases for PECVD the nanofibre growth runs at the base regime with carbon cap. It is worth to note that these nanofibres do not contain metal nanodroplets, which is important for electrodynamic parameters of nanofibres. To note that averaged value of nanofibres length/ diameter ratio is about 35.

For PECVD and all other CVD method it was discovered that highly porous carbon layer is formed on catalytic surface of the reactor. Thickness of this layer is about several tens of microns. For the first time the feedback between thickness of porous layer and temperature of the catalytic surface of the reactor is reported. The decreasing of surface temperature is the basic route of the formation of supersaturated solid carbon solution and, subsequently, the nucleation of carbon clusters [3]. This discovered feedback leads to the nanofibre growth at variable conditions. Manifestation of such unstable growth regime is curved shapes of carbon nanofibres.

Finally, it is shown this carbon layer inevitably leads to quasi-periodic mode of the facility operation and limits its productivity.

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[2] D.A. Takopulo, S.P Fisenko. On formation of carbon clusters on a substrate in plasma pyrolysis of hydrocarbon gases //J. Eng. Phys. Thermophys. 2011. 84, pp. 1083-1086

[3] D.A. Takopulo, S.P Fisenko. Heat and mass transfer in hydrocarbon gas-porous layer-metall system and formation of supersaturated solid solutions of carbon // J. Eng. Phys. Thermophys. 2012. 85 (in press).

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Nanostructuring of Si-based alloy layers induced by fast recrystallization

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In this talk, a short review of phase transitions, structural changes and segregation in Si-based alloy layers during fast melting and crystallization will be done. The samples of continuous layers of epitaxial, polycrystalline and amorphous SiGe alloys as well as nano-dotted layers of Ge or GeSn are used as initial structures. The structures were deposited by MBE, LPCVD, magnetron sputtering or prepared by ion-beam synthesis. The samples were then treated by pulsed laser beam (25-100 ns, 0.2-3.5 J/cm^2). Structural changes and optical properties of heterostuctures are studied by using electron microscopy, RBS/Channelling, photoluminescence, Raman spectrometry, time-resolution reflectivity, atomic force microscopy. The following subjects will be reviewed and discussed: - Fast crystallization of Si-based alloy layers and formation of cellular structures. We will concentrate on segregation of dopant to nanometer-scale cellular network; time-resolved reflectivity measurements of melting, crystallization and segregation; optical properties of segregated cellular SiGe/Si structures. - Pulsed laser modification of Ge and GeSn nanodots. Fast segregation is used for production of non-equilibrium compounds, e.g. metastable Ge1-xSnx dots with a tunable energy band gap. - Laser-induced melting and recrystallization of LPCVD grown polycrystalline Ge layers is used for modification of structural, optical and electronical properties of Ge layers for IR-photodetectors and solar cells due to suitable band-gap and high light absorption.

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