Carbon nanowalls synthesis in the plasma of a radio-frequency discharge

Ye. Yerlanuly[1], D.G. Batryshev[1], M.T. Gabdullin[2], T.S. Ramazanov[1]

[1] *Al-Farabi Kazakh National Universityrsity, Almaty, Kazakhstan*
[2] *Kazakh British Technical University, Almaty, Kazakhstan*

The work is devoted to the synthesis of carbon nanowalls (CNWs) by the method of plasma enhanced chemical vapor deposition in a radio-frequency (RF) discharge plasma at various values of RF discharge power and the study of their properties. As a result of the study, the optimum power parameter for the growth of CNWs with high structure quality was determined.

Carbon nanowalls (CNWs) are two-dimensional carbon nanostructures with vertically oriented graphene sheets, which have a well-developed surface and high specific density. Due to the specific structure, they have interesting physical and chemical properties and potential application for creation of electronic device components, black body like material, etc [1-3]. In our previous work [4] devoted to the study of CNWs synthesis in the plasma of RF discharge, it was found that an increase in the discharge power caused agglomeration of nanowalls into nanoclusters with the formation of defects in the structure. In the present work, we developed a process map of formation of carbon nanomaterials (including CNWs) depending on synthesis parameters.

The CNWs were obtained at different values of RF power and it was found that increasing RF power caused a decrease in the height of CNWs and an increase in their thickness. The optimal conditions of methane flow rate, RF power and growth time were determined for the synthesis of high-quality CNWs. The obtained samples were analyzed by using a Quanta 3D 200i scanning electron microscopy (SEM, the FEI company, USA), NtegraTherma atomic force microscopy (AFM) and Ntegra SPECTRA Raman spectroscopy. The results of the analysis of typical CNWs are presented in Figures 1-3.

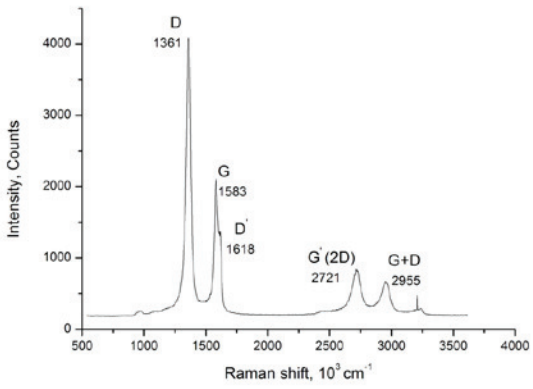

Fig. 1. Raman spectrum of synthesized CNWs

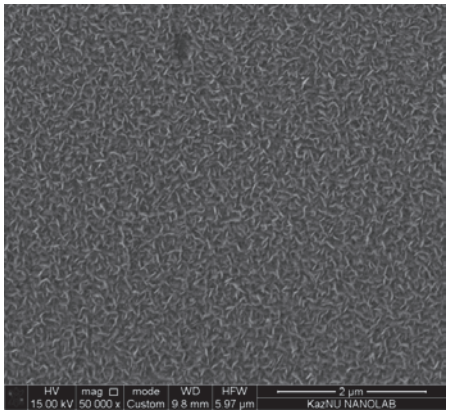

Fig. 1. The SEM images of obtained CNWs

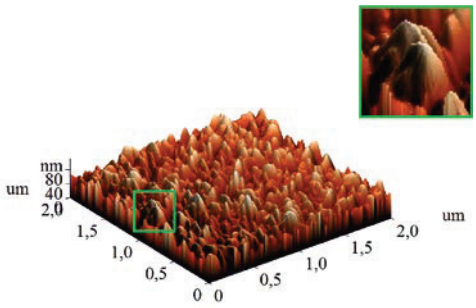

Fig. 2. AFM topography signal of a 2x2 μm2 area of CNWs

According to the SEM, Raman and AFM analysis a process map was developed to chart the zones of CNWs formation with high structure quality.

References

[1] V.A. Krivchenko et al, Sci. Rep., vol. 3, p. 3328, (2013).
[2] S.Y. Kim et al., J. Trans. Electrical and electronic materials, vol. 16, no. 4, pp. 198-200, (2015).
[3] S. Hassan, M. Suzuki, Sh. Mori, A.A. El-Moneim, RSC Adv., vol. 4, p. 20479, (2014).
[4] D.G. Batryshev, Ye. Yerlanuly, T.S. Ramazanov, M.K. Dosbolayev, M.T. Gabdullin, J. Mater. Today: Proc., vol. 5, no. 11, pp. 22764–22769, (2018).