A new method for the preparation of a single metallic nanowire by electrodeposition

H. Chiriac[1], O.G. Dragos-Pinzaru[2], G. Stoian[3], T.A. Ovari[4], and N. Lupu[5]

[1]National Institute of Research & Development for Technical Physics, Iaşi, Romania, hchiriac@phys-iasi.ro
[2]National Institute of Research & Development for Technical Physics, Iaşi, Romania, odragos@phys-iasi.ro
[3]National Institute of Research & Development for Technical Physics, Iaşi, Romania, gstoian@phys-iasi.ro
[4]National Institute of Research & Development for Technical Physics, Iaşi, Romania, taovari@phys-iasi.ro
[5]National Institute of Research & Development for Technical Physics, Iaşi, Romania, nicole@phys-iasi.ro

The preparation of simple and multilayer nanowires has attracted considerable attention in recent years because their physico-chemical properties. The electrodeposition into the nanopores of different templates is widely used for preparing magnetic simple or multilayered nanowires. The diameter of the electrodeposited nanowires could vary from 30 to 400 nm and their length is limited by the thickness of the template (usually 40 or 50 μm). Additionally, the large density of the nanowires per cm^2 (10^7-10^8) is influencing strongly the magnetic and magnetotransport properties. Thus, it is desirable to prepare single nanowires with controllable diameters and lengths, and with both ends free for making electrical contacts.

Very recently, our group reported the preparation of glass-coated magnetic nanowires with diameters down to 100 nm by a rapid quenching technique [1,2]. Due to the constraints of the method of preparation the compositions of such glass-coated nanowires are restricted to the ones with glass-forming ability. In this paper, we report a new method to prepare single metallic nanowires with diameters of 100-200 nm and different compositions. The new method proposed in this paper combines the glass-coating and electrodeposition. We prepared Ag glass-coated nanowires with the diameter of the metallic core ranging from 100-200 nm and the glass coat thickness of about 10 μm by the technique described in refs. 1 and 2. By chemical corrosion we are removing the Ag core from one end of the glass-coated nanowire on a length of a few mm. Using a focused ion beam (FIB) the glass coat from the other end is removed on a length of 5-10 μm to uncover the Ag core. By thermal evaporation we are depositing on the uncovered Ag core an additional layer of Ag of 500 nm, which will be further used as cathode in the electrodeposition cell. In this way the empty glass tube (from which the Ag core was removed chemically) can be filled with any type of metal suitable for electrodeposition. The method offers the advantage of manipulating the new prepared single nanowire, because of the total diameter of the assembly nanowire-glass coat which is in the μm range. The so prepared nanowires can be simple or consisting of multilayered structures, depending on the composition of the electrodeposition bath.

By using the new method, we succeeded preparing single glass-coated [NiFe(50 nm)/Cu(20 nm)] x n multilayered nanowires by switching between the deposition potentials of the two constituents (-1.4 V and -0.3 V for NiFe and Cu deposition, respectively). The results are comparable with the ones reported for NiFe/Cu multilayered nanowires prepared by electrodeposition in alumina templates with thicknesses of only 40 μm [3]. The new prepared nanowires have lengths in the mm range, and can be easily used for logic devices or biomedical applications. For the biomedical applications the glass coat can be used for bonding different other ligands or biomolecules.

[1] H. Chiriac, S. Corodeanu, M. Lostun, G. Ababei, T.-A. Óvári, J. Appl. Phys. 107 (2010) 09A301.
[2] H. Chiriac, S. Corodeanu, M. Lostun, G. Stoian, G. Ababei, T.-A. Óvári, J. Appl. Phys. 108 (2011) in press.
[3] H. Chiriac, O.G. Dragos, M. Grigoras, G. Ababei, N. Lupu, IEEE Tran. Magn. 45 (2009) 4077.