W- based superconducting ultranarrow nanowires grown by Focused-Ion-Beam induced deposition

R. Córdoba[1,2], J. Sesé[1,2], M. R. Ibarra[1,2,3], I. Guillamón[4], H. Suderow[4], S. Vieira[4], J. J. Palacios[5] and J. M. De Teresa[2,3]

[1]Instituto de Nanociencia de Aragón, Universidad de Zaragoza, Zaragoza, 50018, Spain
[2]Departamento de Física de la Materia Condensada, Universidad de Zaragoza, Zaragoza, 50009, Spain
[3]Instituto de Ciencia de Materiales de Aragón, Universidad de Zaragoza-CSIC, Zaragoza, 50009, Spain
[4]Laboratorio de Bajas Temperaturas, Departamento de Física de la Materia Condensada, Instituto de Ciencia de Materiales Nicolás Cabrera, Facultad de Ciencias, Universidad Autónoma de Madrid, E-28049, Madrid, Spain
[5]Departamento de Física Teórica de la Materia Condensada, Universidad Autónoma de Madrid, Madrid 28049, Spain

rocorcas@unizar.es

The fabrication of superconducting nanostructures is opening interesting research fields in Nanotechnology [1]. Focused-ion-beam-induced-deposition (FIBID) is a powerful single-step technique that allows the control of the growth of nanostructures on any substrate where precursor gas molecules are adsorbed and dissociated by the focused-ion-beam (FIB) scanning [2]. It was found that FIBID can produce superconducting W-based nanostructures with T_C ~5 K [3]. Recently, it was demonstrated using Scanning Tunnel Microscopy/Spectroscopy (STM/S) techniques that this material follows the BCS theory precisely, allowing for the direct observation of the melting of the two-dimensional vortex lattice, and the motion of vortex bundles with preferential direction [4]. Its technological potential has also been demonstrated for the repair of damaged micro-SQUIDs or the conversion of SQUIDs into highly sensitive SQUID-susceptometers [5].

In the present work, we report the growth of W-FIBID superconducting ultranarrow nanowires (NWs) with the minimum lateral size (~50 nm) achieved so far by means of FIBID (Figure 1). The dependence of resistivity as a function of temperature for the studied samples showed similar behaviour to the one found previously for microwires and wider NWs (Figure 2) [6]. These nanostructures could be relevant in nanoscale superconductivity, as for instance in the topics of one-dimensional superconductivity, SQUID sensors, vortex confinement and pinning, opening a new route to tailor vortex effects in nanometric superconductors.

References

[1] M. Velez et al., J. Magn. Magn. Mater. **320** (2008) 2547.
[2] I. Utke, P. Hoffmann, and J. Melngailis, J. Vac. Sci. Technol. B **26** (2008) 1197.
[3] E. S. Sadki, S. Ooi, and K. Hirata, Appl. Phys. Lett. **85** (2004) 6206.
[4] I. Guillamón et al., New Journal of Physics **10** (2008) 093005; I. Guillamón et al., Nat Phys **5** (2009) 651; I. Guillamón et al., Phys. Rev. Lett. in press.
[5] M. J. Martínez-Pérez et al., Supercond. Sci. Technol. **22** (2009) 125020.
[6] J. M. De Teresa et al., Mater. Res. Soc. Symp. Proc. **1180** (2009) CC04-09.

Figures

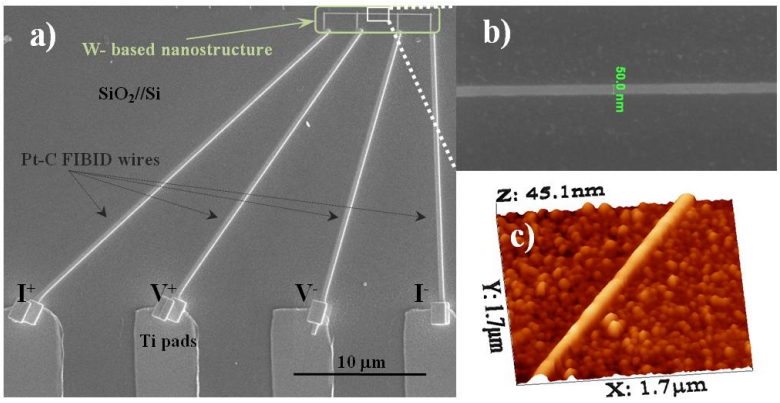

Figure 1: a) SEM image of the experimental configuration for four-wire electrical measurements. b) SEM image of the deposited horizontal NW of W- based nanostructure. c) AFM image of the deposited horizontal NW of W- based nanostructure.

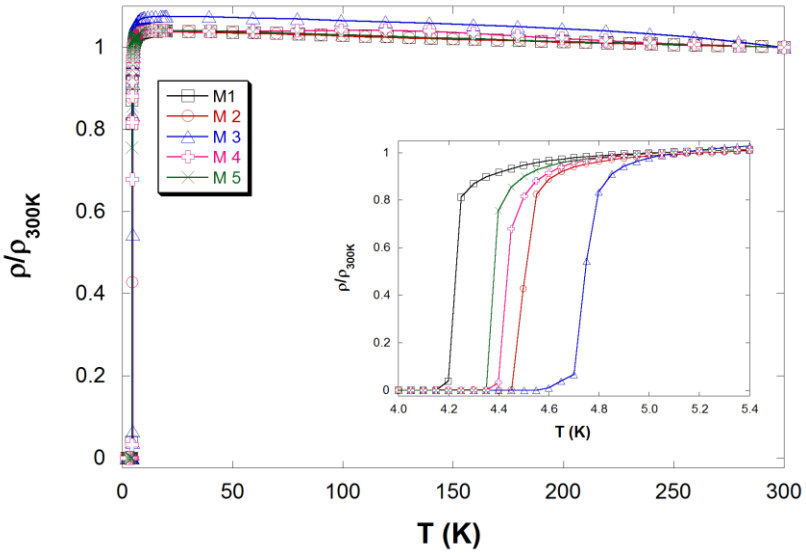

Figure 2: Normalized resistivity of W- based ultranarrow NWs as a function of the temperature. The detailed evolution of the normalized resistivity close to critical temperature is shown in the inset.