

Superconducting tungsten nanowire fabricated by Focused-Electron-Beam Induced Deposition (FEBID)

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Focused-Electron-Beam Induced Deposition (FEBID) is a direct writing method for the fabrication of 2D and 3D nanostructures. It has developed over the last decade from an exotic technique used by a small number of specialists for limited, but important applications such as mask repair, to a highly versatile technology used in various research areas. It consists of a gas injection system, installed inside of an electron microscope chamber, which delivers precursor molecules. These molecules are then dissociated in the focus of the electron beam. This process can either prompt a deposition of the precursor or the etching of the substrate surface by chemical reaction. The process is mostly triggered by the low energy electron, i.e. the secondary electrons generated by the primary electron and the backscattered electrons. The precursor of the molecule is often a metal (W, Pt, Co...), but can also be a semiconducting or insulating material.

Clean bulk tungsten has a low superconducting transition temperature of $T_c = 15$ mK. T_c can however be increased by introducing disorder and carbon, which FEBID does inherently. Here we show the fabrication of a superconducting tungsten nanowire by FEBID. The resistance as a function of temperature shows a pronounced drop around 2.5 K indicating a superconducting transition (Fig.1 Right). T_c is usually determined as the temperature at which the resistance corresponds to 90% of the normal resistance. It is here found to be 2.6K. The residual resistance of $\sim 260 \Omega$ indicates that not all parts of the wire have become superconducting due to the inhomogeneous tungsten carbide deposition during the FEBID process.

The fabrication of this superconducting tungsten nanowire is a first step towards more advanced quantum nanodevices using FEBID.

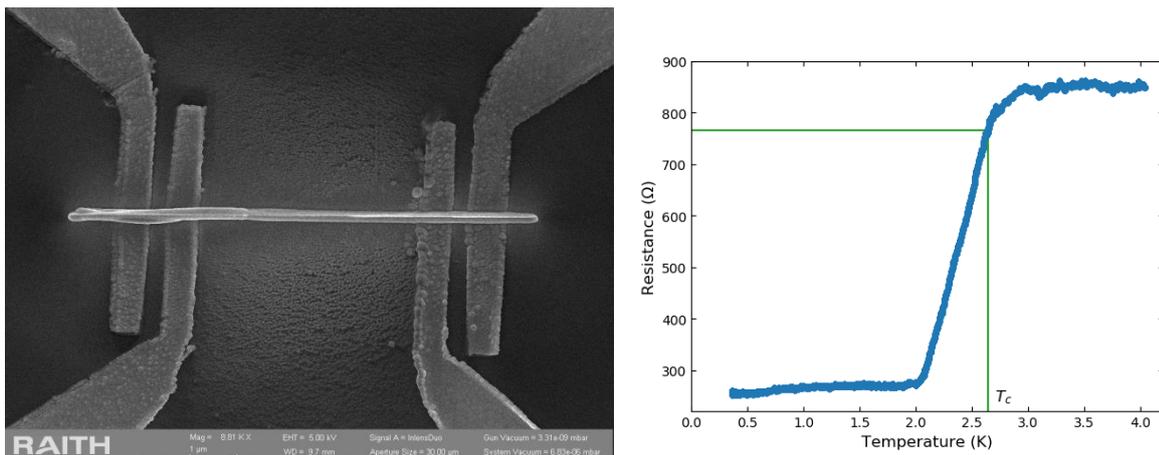


Figure 1 – (Left) SEM micrograph of a tungsten wire (horizontal line) fabricated by FEBID in a 4-point measurement configuration onto prepatterned contact leads made of Cr/Au. (Right) Resistance as a function of the temperature for a W nanowire fabricated by FEBID and guide used to estimate T_c