Nanocomposites and nanomaterials

Structural and transport characteristics of superconducting MoRe-Si(W)-MoRe junctions

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We investigated complex microstructure of the fabricated hybrid silicon-tungsten Si(W) heterostructures, and as a result we see the appearance of quasi-periodical two-dimensional net of tungsten nanoclusters which has been formed in the amorphous silicon (weakly conducting) matrix at some deposition parameters. We think the charge transport through these clusters plays the major role in these heterostructures. By changing the technological conditions for the formation of the heterostructures it becomes possible to control the shape and distribution of these metal nanoclusters in the hybrid barriers and, thus, have a significant influence on their transport characteristics.

In our case we use the phase-sensitive method of investigation of the hybrid barrier surface relief by atomic-force microscope (AFM) in non-contact mode because it's well known this method now is the most informative one for the microstructure investigations.

As it's known the AFM detects the Van der Waals forces of the atomic clusters, so as a result we see enlarged images of the real tungsten clusters (inserted in the silicon), and we think the real cluster diameter is close 50 -70 nm. Current-voltage characteristics (CVCs) of the samples have been measured in a wide voltage range from -900 mV to 900 mV at temperatures from 4.2 K to 8 K. At relatively high tungsten content in the barrier we have observed emergence of the Josephson effect. We have observed large excess quasiparticle currents I_{exc} in the dissipative part of current-voltage characteristics, that is a strong evidence of intensive electron-to-hole Andreev reflections in these junctions. When the W content in the barrier was decreased, the Josephson current disappeared, and we have observed resonant current peaks in the CVCs at bias voltages from 40 mV to 300 mV, that were symmetrical for positive and negative voltages.