K. Arutyunov

University of Jyväskylä, Department of Physics, NanoScience Centre, Finland

Quantum fluctuations in ultranarrow superconducting nanowires.

Below a certain (typically cryogenic) temperature Tc some materials lose their electric resistance R entering superconducting state. Following the general trend toward a large scale integration of a greater number of electronic components, it is desirable to use superconducting elements in order to minimize heat dissipation. It is expected that the basic property of a superconductor, i.e., dissipationless electric current, will be preserved at reduced scales required by modern nanoelectronics. However, it is a known fact that there is certain range of temperatures close to the critical one, where a superconductor is in a so called 'resistive state' providing non-zero resitance. Moreover, there are indications that there is a certain critical diameter on the order of 10 nm, below which a 'superconducting' nanowire is no longer a superconductor in a sense that it acquires a finite resistance even at temperatures close to absolute zero.

Method of progressive and nondestructive reduction of effective diameter of a nanowire has been applied to trace evolution of the shape of superconducting transition R(T). Here we report experimental evidence of superconductivity breakdown in ultranarrow quasi-1D aluminum and tin nanowires. Apart from suppression of superconductivity due to quantum fluctuations, size effects result in modulation of the critical temperature Tc and unusual negative magnetoresistance in the very thinnest samples. The experimental results are in a reasonable agreement with existing theoretical models.

References:
1. M. Zgirski, K. P. Riikonen, V. Touboltsev, and K. Arutyunov, Nano Lett. 5, 1029 **(**2005**)**
2. A. A. Shanenko, M. D. Croitoru, M. Zgirski, F. M. Peeters and K. Yu. Arutyunov., Phys. Rev. B 74, 052502 **(**2006).