Unexpected Giant Superconducting Fluctuation and Anomalous Semiconducting Normal State in NdO$_{1-x}$F$_x$Bi$_{1-y}$S$_2$ Single Crystals

XIYU ZHU$^1$, JIANZHONG LIU, DELONG FANG, Nanjing University, ZHENYU WANG, Chinese Academy of Sciences, JIE XING, ZENGYI DU, HUAN YANG, HAI-HU WEN, Nanjing University, CENTER FOR SUPERCONDUCTING PHYSICS AND MATERIALS TEAM — Experiments on single crystals of BiS$_2$-based superconductors are highly desired. We report the successful growth of the NdO$_{1-x}$F$_x$Bi$_{1-y}$S$_2$ single crystals. Resistive and magnetic measurements reveal that the bulk superconducting transition occurs at $T_c = 4.83$ K, while an unexpected giant superconducting fluctuation appears at temperatures as high as 2-4 kBTC. Analysis based on the anisotropic Ginzburg-Landau theory gives an anisotropy $\gamma = \sqrt{m_c/m_{ab}} \approx 30 \sim 45$. Two gap features with magnitudes of about $3.5 \pm 0.3$ meV and $7.5 \pm 1$ meV were observed by scanning tunneling spectroscopy. The smaller gap is associated with the bulk superconducting transition yielding a huge ratio $2\Delta_1/k_BT_c = 16.8$, the larger gap remains up to about 26 K. The normal state recovered by applying a high magnetic field shows an anomalous semiconducting behavior. All these suggest that the superconductivity in this newly discovered superconductor cannot be formatted into the BCS picture.

$^1$Center for Superconducting Physics and Materials, National Laboratory of Solid State Microstructures and Department of Physics, Nanjing University, Nanjing 210093, China

Xiyu Zhu
Nanjing University

Date submitted: 11 Nov 2013

Electronic form version 1.4