Scanning Tunneling Spectroscopic Studies on Nanostripes Observed on (NEG)$Ba_2Cu_3O_x$ Single Crystals

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Most high-T_c superconductors based on light rare earths (LRE) are known to possess self organized stripe structures at the nanometer scale. Surface characterizations of these materials by atomic force microscopy and scanning tunneling microscopy (STM) at room temperature and in air revealed the stripes of wavelength between 10 nm – 60 nm [1-3]. These stripes, which were found to be pronounced on melt-textured samples of (Nd,Eu,Gd)$Ba_2Cu_3O_x$ (NEG), are considered as self-organized flux pinning centers. However, the direct probe of these pinning centers are so far lacking.
Scanning tunneling microscope offers the possibility to probe the local electronic properties of a conducting material. Thus, it is a useful tool to probe the superconducting properties of a high-T_c material and has been extensively used to study the nanoscale electronic proeperties on flat surfaces of high quality high-T_c single crystals. Recently, it has been possible to grow single crystals of NEG. We have performed scanning tunneling microscopic and spectroscopic studies of NEG single crystals in the normal and superconducting state under UHV conditions. The as-grown surfaces of the NEG single crystals exhibit self-organized stripes of an average periodicity between 500 and 800 nm which is more than 10 times the periodicity of stripes observed in melt-textured samples. Spectroscopic studies deep into the superconducting state of these crystals show that on the line structures forming the stripes, there is a gap like feature in the density of states (DOS) obtained in terms of the dI/dV curves which are very similar to the curves obtained on the most of the sample surface indicating superconductivity at these regions. On the other hand, STS data reveal no gap like features in the DOS at the dip regions observed on both sides of stripe lines on the topographic images, thus showing no superconducting properties. These dip regions are ~20 nm wide. Therefore, our work shows the possible flux pinning centers close to the self-organized lines forming stripes on the surfaces of NEG single crystals.

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