Scanning tunneling spectroscopic studies of (100) surface of NdBa2Cu3O7- single crystals

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Abstract:

$NdBa_2Cu_3O_{7-\delta}$ (NdBCO) is an important member of cuprate high-T_c superconductors because of its higher transition temperature as compared to $YBa_2Cu_3O_{7-\delta}$ and critical current density. The similar sizes of the Nd and Ba ions make it possible for Nd ions to replace the Ba ions in the unit cells producing Nd rich phases leading to a spatial T_c variation within the sample. The samples with Nd rich second phases is believed to play an important role in flux pinning [1]. The variation of transition temperature due to the presence of this Nd rich phase is reported to play an important role to explain the increased critical current performance. However, the nature of the basic pinning mechanism needs to be studied in detail. Scanning tunneling spectroscopic studies of these materials are, therefore, necessary to understand the microscopic electronic properties. In this contribution, we report the results of Scanning Tunneling Spectroscopic (STS) measurements performed on the (100) surface of a NdBCO single crystal (T_c = 95.5 K) using a homemade STM at T = 4.2 K. The surface of the crystal was cleaned by chemical etching before doing the measurements [2].

A variety of conductivity (dI/dV) curves were observed in a chosen range of 20 nm × 20 nm. The peak to peak values of the energy gaps ($2\Delta_{pp}$) found from the curves, normalised with respect to the tip to sample distance, to be 59(+\-)8 meV. A position dependent asymmetry in the peak value of dI/dV at the gap edges have been repeatedly observed. At several positions of the sample very low peaks at the gap edges or sometimes no peaks were observed. We observe the second phase electronic properties that are reflected in our conductivity data. Here, we discuss these results and their possible consequences on the pinning mechanism that are accessible by macroscopic measurements.

1. M. R. Koblischka et al., Phys. Rev. B 58 (1998) 2683
2. R. P. Vasquez et al., Appl. Phys. Lett. 53 (1988) 2692