Fabrication of Interface-controlled Josephson Junctions by Ion Beam Damage

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One of the main goals of research on high-temperature superconducting (HTS) Josephson junctions has been the development of a reproducible process for fabricating highly uniform junctions. Among the several fabricating methods, interface-controlled $YBa_2Cu_3O_y$ (YBCO) junctions have attracted much attention since the fabricating process is quite suitable for digital circuit applications. The basic concept of an interface-controlled junction is to create a thin barrier layer by alternating the structure or stoichiometry of the YBCO base electrodes only at the surface. This structural and stoichiometrical difference can be directly related to the improved electrical properties of interface-controlled junctions. However, the structure of the interface barrier and its formation mechanism, as well as the current transport in the junctions, has not been fully understood. The ion milling and annealing treatment used in the interface-controlled method forms a continuous barrier layer of 2 to 3 nm in thickness, much thinner than the artificially deposited interfaces. Therefore, the fabrication of ICJs is an important key factor that optimizes the ion milling and annealing conditions.
In optimizing the fabricating factors, the interface-controlled junctions showed resistively shunted junctions like current-voltage characteristics and an excellent uniformity. These junctions exhibited a spread (1 σ) of I_c is 10 % for chips containing 7 junctions at 50K.

keywords : Josephson junctions, interface-controlled junctions, ion beam etching, annealing