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X-ray crystal structures of Al-doped (Y,Ca)$Ba_2Cu_3O_{7y}$ whiskers

Al^{+3}-doped (Y,Ca)$Ba_2Cu_3O_{7y}$ (YBCO) whiskers have been synthesized using a solid-state reaction technique. These materials are promising candidates for solid-state THz applications based on sequences of Josephson Junctions (IJJs). Alumina addition was systematically varied and the effect of aluminium incorporation on the structure has been investigated using single-crystal X-ray diffraction. Aluminium only replaces Cu atoms in the O–Cu–O–Cu chains and a gradual transition from orthorhombic to tetragonal space group occurs, thus increasing the Al content. A gradual modification of the coordination sphere of the copper site has also been observed. The Ca^{2+} ion substitutes mainly the Y^{3+} ion and also, to a small extent, the Ba^{2+} ion.

1. Introduction

In high-T_c superconductors (HTSC) such as $Bi_2Sr_2CaCu_2O_{8+}$ (Bi-2212), $YBa_2Cu_3O_7$ (Y-123) and, more in general, RE123 (RE = Y, Eu, Gd, Dy, Ho, Er, Tm and Lu), stacks of intrinsic Josephson junctions (IJJs) with atomic sizes are naturally present as a result of their crystal structure (Kleiner et al., 1992; Kawae et al., 2005; Okutsu et al., 2008). A series of recent publications has shown that IJJs can be employed as the core components for the fabrication of several cryogenic micro-devices such as THz emitters (Ozyuzer et al., 2007) and sensors (Wang et al., 2001), micro-SQUIDs (Sandberg & Krasnov, 2005) and phase qubit applications based on the macroscopic quantum tunneling effect (Inomata et al., 2005; Martinis et al., 2005). Therefore, besides the needs related to the fundamental studies of structural and physical properties of HTSC, the growth of high-quality single crystals of these materials represents a crucial issue for their technological exploitation.

From this point of view, the possibility of growing crystals with high aspect ratios, also known as whiskers, has received considerable attention because of their highly crystalline nature, excellent superconducting properties and micrometric cross section area, which allow the fabrication of threedimensional devices with a high degree of