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# Photoconductivity effects in mixed-phase BSCCO whiskers

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**Abstract**
We report on combined photoconductivity and annealing experiments in whisker-like crystals of the Bi–Sr–Ca–Cu–O (BSCCO) high-$T_c$ superconductor. Both single-phase $Bi_2Sr_2CaCu_2O_{8+\delta}$ (Bi-2212) samples and crystals of the mixed phases $Bi_2Sr_2Ca_2Cu_3O_{10+x}$ (Bi-2223)/Bi-2212 have been subjected to annealing treatments at 90 °C in air in a few hours steps, up to a maximum total annealing time of 47 h. At every step, samples have been characterized by means of electrical resistance versus temperature ($R$ versus $T$) and resistance versus time at fixed temperature ($R$ versus $t$) measurements, both in the dark and under illumination with a UV–Vis halogen arc lamp. A careful comparison of the results from the two techniques has shown that, while for single-phase samples no effect is recorded, for mixed-phase samples an enhancement in the conductivity that increases with increasing annealing time is induced by the light at the nominal temperature $T = 100$ K, i.e. at an intermediate temperature between the critical temperatures of the two phases. A simple pseudo-1D model based on the Kudinov's scheme (Kudinov *et al*, 1993 *Phys. Rev.* B **47** 9017–28) has been developed to account for the observed effects, which is based on the existence of Bi-2223 filaments embedded in the Bi-2212 matrix and on the presence of electronically active defects at their interfaces. This model reproduces fairly well the photoconductive experimental results and shows that the length of the Bi-2223 filaments decreases and the number of defects increases with increasing annealing time.

(Some figures may appear in colour only in the online journal)

## 1. Introduction

The interaction between electromagnetic radiation and transport properties of materials is an interesting and extensively studied topic. In semiconductors, for instance, an enhancement of the electrical conductivity is commonly observed as a consequence of illumination, which is also known as photoconductivity. Concerning superconductors, it was shown in the past that illumination with visible light induces detrimental effects on the superconductivity of materials with low critical temperature ($T_c$) due to the breakdown of the Cooper pairs, which results in a quasiparticle excess and therefore in an increased effective temperature of the system [1]. A similar behaviour has been detected also in high-$T_c$ superconductors (HTSC), but only at sub-nanosecond timescales and very low photon doses [2]. In contrast, when the excitation timescale is at least of the order of milliseconds and at higher photon doses ($\geq 10^{19}$ photon cm$^{-2}$), HTSC can exhibit an enhancement in their superconducting properties (e.g. $T_c$ and the critical current density, $J_c$) that persists after the light is turned off, provided that these materials are kept at low enough

 