Comment on ‘‘Enhanced J c ’s of YBa2Cu3O7−x –Ag ex situ annealed coevaporated films on LaAlO3 (100) substrates’’ [Appl. Phys. Lett. 65, 2350 (1994)]

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Comment on "Enhanced J_c's of $YBa_2Cu_3O_{7-x}$–Ag *ex situ* annealed coevaporated films on $LaAlO_3$ (100) substrates" [Appl. Phys. Lett. 65, 2350 (1994)]

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In a recent letter, Clausen *et al.*[1] reported a 5× increase in critical current density J_c of Ag-coated $YBa_2Cu_3O_{7-x}$ (1 MA cm^{-2}) film compared to the uncoated one (0.2 MA cm^{-2}) at 77 K. The enhancement is attributed to the superior properties of the former, viz., improved microstructure, crystallinity, and elemental distribution. On the other hand, the Auger electron spectroscopy (AES) results indicate a considerable variation in the reported composition of the film. Almost all the reports,[1–4] including the one under discussion, show that the elemental concentrations are constant throughout the entire film, i.e., a homogeneous distribution. On the contrary, they have failed to retain the 1-2-3-7 stoichoimetry and are far different from the ideal composition, $YBa_2Cu_3O_{7-x}$.

The composition of $YBa_2Cu_3O_{7-x}$–Ag film [Fig. 1(a); from Ref. 1] differs considerably from the high quality $YBa_2Cu_3O_{7-x}$ film or single crystal Figs. 1(b) and 1(c); from Ref. 5]. The following can, however, be thought of as possible reasons for the compositional ambiguity encountered in the Ag-coated film,[1] viz., the localized enhancement of copper, preferential sputtering of the components and/or standard sensitivity factors[6] (SSF) used for the quantification of AES data. No doubt silver enhances the J_c in the $YBa_2Cu_3O_{7-x}$ films but the values[1] are much lower than the reported ones (5–14 MA cm^{-2}).[7,8] The average composition of the coevaporated $YBa_2Cu_3O_{7-x}$–Ag film [1] is rich in copper and deficient in oxygen, as compared to the laser ablated $YBa_2Cu_3O_{7-x}$–Ag films[9] as well as undoped $YBa_2Cu_3O_{7-x}$ films and single crystals.[5] It is, however, nearly constant in the latter cases, close to ideal stoichiometry. Hence, it is tempting to correlate the low J_c values to the compositional variation.

The significant difference in oxygen concentration (~20%) cannot be accounted for the ion-induced oxygen loss alone. At the same time, it is to be noted that the sputtering yields of copper and yttrium are of equal magnitude[10] and that the Ag-coated films show high copper concentration with no proportional change in the yttrium content implying the sputtering induced effects are almost absent. Last, the key problem to quantitative AES measurements is the difficulty encountered in the calibration of the specific Auger signals in terms of elemental concentrations. To over come this, a calibration procedure is often performed to determine the relative sensitivity factors[5,9] (RSF) on stoichiometrically known $YBa_2Cu_3O_{7-x}$. The significant variation in the SSR and RSF values eventually make all the difference in the quantification of the AES data.[5,9,11]

In summary, it is not, therefore, unreasonable to conclude that the altered composition is responsible for marginal J_c and that excess copper present as a secondary phase could be the main cause for the scattering in the elemental distribution.

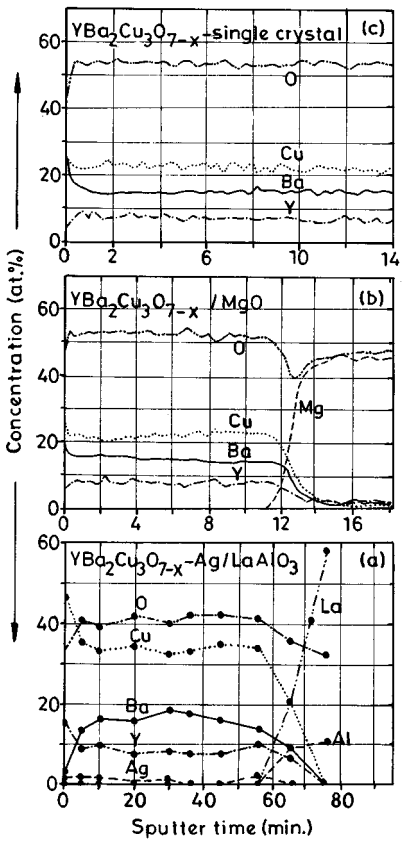

FIG. 1. Typical Auger depth profiles of: (a) coevaporated film coated with silver; (b) rf sputtered film; (c) crystal grown by self-flux method.

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