Response to "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. 67, 3650 (1995)]

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In a comment[1] to our recent letter,[2] Selvam has questioned our conclusions on the effect of Ag in improving the critical current density in YBCO thin films. The basis for his criticism is our results from sputter depth Auger electron spectroscopy (AES), where in the figure (Fig. 4, Ref. 2) it seems that there is an excess of copper while the oxygen concentration is low by some 20%. We believe that the principle of the criticism is warranted due to a lack of information concerning the calculation of the atomic concentration profile.[2] On the other hand, we believe that the conclusions drawn by Selvam are erroneous. Selvam claims that we have failed to retain the 1-2-3-7 stoichiometry on the basis of the AES analysis. However, the AES analysis was not used to control the stoichiometric ratio between the Y, Ba, Cu, and O, since we had no exact knowledge of the sensitivity factors for the four atomic species when sputtered from the YBCO compound. Instead we used the standard stabilized factors to calculate the atomic concentration profiles, but this was not mentioned in the letter as it of course should have been. The stoichiometric ratio was checked with two other techniques namely the inductively coupled plasma (ICP) technique and energy dispersive x-ray analysis (EDAX). Both showed (Table I) that the 1-2-3 stoichiometry indeed was obtained. In addition, x-ray diffraction experiments on Ag-doped thin films has shown that the oxygen concentration is indeed close to $7 (x \sim 6.9)$.[3]

Selvam also comments on the magnitude of the reported value of J_c (77 K) for the Ag-doped film. Indeed, this value is low but recent experiments on Ag-doped YBCO films have shown that J_c (77 K) is very dependent on the nominal film thickness.[2] The highest values of J_c(77 K) is obtained for thin films with a nominal film thickness below 300 nm $[J_c(77\ \text{K}) = 4-6\times 10^6\ \text{A/cm}^2]$[2]. For Ag-doped YBCO films with a nominal film thickness above 300 nm J_c(77 K) rapidly drops to values just above 10^6 A/cm^2.[3]

TABLE I. Results on stoichiometric check on Ag-doped YBCO film with ICP and EDAX.

Element	Stoichiometric compound (at. %)	ICP Ag–YBCO (at. %)	ICP bulk-YBCO (at. %)	EDAX Ag–YBCO (at. %)
Y	7.69	7.31	7.84	7.49
Ba	15.38	15.53	15.07	15.41
Cu	23.08	23.31	23.23	23.24
O	53.85	NA[a]	NA[a]	NA[a]

[a]NA means that the information is not available from the technique used. For the calculation we have assumed that the oxygen content x is close to 7.

In summary, we believe that the conclusions made by Selvam on the enhancement on J_c (compositional variations due to excess copper) are erroneous. Our ICP and EDAX measurements show that the Ag-doped YBCO film have a composition close to the ideal 1-2-3-7 stoichiometry.

[1] P. Selvam, Appl. Phys. Lett. **67**, 3650 (1995).
[2] T. Clausen, M. Ejrnæs, M. Olesen, K. Hilger, J. L. Skov, P. Bodin, A. Kühle, and I. Chorkendorff, Appl. Phys. Lett. **65**, 2350 (1994).
[3] T. Clausen, J. L. Skov, C. S. Jacobsen, K. R. Bukh, M. V. Bollinger, B. P. Tobiasen, M. P. Sager, and I. Chorkendorff (unpublished).

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