Preparation of Tl-1223 superconducting films with high transport J_c by spray pyrolysis

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Tl-1223 films, about 1 μm in thickness, have been fabricated in a two step process involving the deposition of a precursor layer with composition $Ba_2Ca_2Cu_3O_7$ by spray pyrolysis and a subsequent *ex situ* thallination performed in a closed system with a pellet of composition $Tl_{0.9}Ba_2Ca_2Cu_3O_z$ as a source of thallium. Preliminary studies, conducted with the conditions retained for the preparation of bulk samples [1], showed that a highly pronounced biaxial texture was obtained on $LaAlO_3$ single crystal substrates while the films deposited on MgO substrates were found to have a large number of randomly oriented grains. These films are superconducting with T_c onsets ranging from 108 to 113 K. The critical current densities, deduced from magnetisation measurements, were found two orders of magnitude larger for films grown on $LaAlO_3$ (7×10^5 A/cm^2) than for films grown on MgO (2×10^3 A/cm^2) in agreement with the observed differences in microstructure.

The pathway for the formation of Tl-1223 films was found identical to that observed in bulk samples [2,3]. The last step of this process is the transformation from Tl-2223 to Tl-1223 which is well described by a $n = 2$ order reaction with an activation energy of 225±17 kJ/mol. The study of the formation kinetics also gave the time-temperature window within which it is necessary to operate.

Finally, fluorine addition was found highly beneficial to the layer morphology. It favours grain growth and alignment and provokes a levelling of the layers which are therefore denser and smoother (Fig. 1). This improvement of the morphology is reflected in the properties. Transport critical current densities as high as 7×10^5 A/cm^2 have been measured on 0.1×1.6 mm^2 bridges.

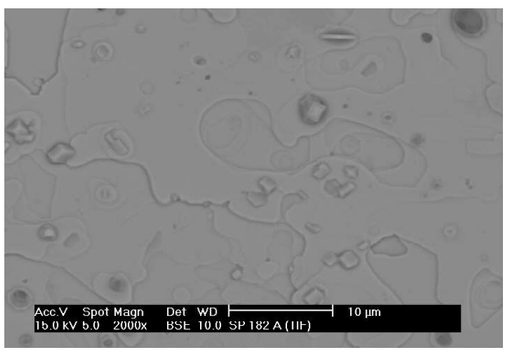

Fig. 1 F-containing Tl-1223 film grown on $LaAlO_3$

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[2] E. Ruckenstein and C.T. Cheung, *J. Mater. Res.*, **4**, 1116 (1989).
[3] J.L. Jorda *et al*, *J. Supercond.*, **11**, 87 (1998).