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Fabrication of 2G HTS wires with artificial pinning centres using production scale PLD system and characterisation of their superconducting properties

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An industrial R&D programme is ongoing at SuperOx, aimed at improving 2G HTS wire performance in magnetic field. We introduce perovskite artificial pinning centres into the HTS layer matrix. In contrast to most studies described in the literature, we use the high rate production processing parameters and PLD equipment at SuperOx Japan. This paper reports the results of Phase 1 of this programme.

We fabricated 2G HTS wires using GdBCO PLD targets with 0-7% (wt.) BaZrO₃ or BaSnO₃ at 100, 150 and 200 Hz frequency. The crystal structure and texture parameters of the HTS layer and perovskite inclusions were characterised with XRD. The HTS layer microstructure and morphology were studied with TEM. The angular dependencies of the critical current of the samples were measured by 4-probe transport technique at 77 and 65 K in 1 T magnetic field and derived from magnetic hysteresis curves measured in PPMS in the 4.2-77 K temperature range and 0-9 T magnetic field range.

BaZrO₃ and BaSnO₃ formed column-shaped semi-coherent nano-inclusions in the GdBCO film matrix. The typical transverse size of the nano-columns was about 5 nm, and their volume density correlated with the dopant concentration. All doped samples exhibited much lower angular anisotropy of in-field critical current and higher lift factors than undoped samples. Doped samples demonstrated higher minimum critical current for all field orientations than undoped samples at 65 K and at lower temperatures.

These results are an encouraging start of our programme, as they show a positive impact of artificial pinning centres introduced into 2G HTS wires fabricated at production throughput. Future work will be focussed on the optimisation of PLD growth parameters, in order to maximise the improvements in specific temperature and field conditions, as well as on the verification of reproducibility of the improvements in production wires.

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