The Microstructure of YBCO Single Crystals Grown by the LMPG Method

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1. Introduction

Many applications of high-T_c superconductors(HTSC) will necessitate superconducting wires with high critical current densities. The laser-melted pedestal growth(LMPG) method has much more advantages than the other directional growth method in the preparation of HTSC wires. First of all, the growth rate can be increased because the thermal gradient(G) to growth rate(R) ratio is large. Secondly this technique can also produce single crystals, even in non-congruent melting systems. The YBCO superconductors has a peritectic melting behavior and is therefore suceptible to be grown by this technique. This study is to investigate the growth conditions and microstructure of YBCO superconducting wires grown by LMPG method.

2. Experimental

The raw materials of Y_2O_3, $BaCO_3$ and CuO were mixed in the ratio of 123:211=80:20(wt%) and calcination at 900℃ for 12hrs was repeated three times. YBCO wires with diameter between 0.5 and 1mm were formed by a plastic extrusion technique. The extrusion pastes of YBCO were prepared by ethyl-celluose binder. Extruded wires were sintered at 950℃ for 12hrs. The sintered wires were then zone melted by LMPG apparatus. The grown YBCO wires were oxygen annealed at 460℃ with varying annealing times. The microstructure of polished samples was examined by optical microscope and SEM.

3. Results

1). YBCO superconducting wires with single crystal type were obtained by the LMPG method. The appropriate melting zone temperatures and growth rates are in the range of 1100-1150℃ and 5-10mm/hr respectively.

2) At the top of the zone-melted samples, many randomly oriented grains have been formed. The number of grains decrease with progressing solidification front due to grain selection at the solid-liquid interface. Finally there is one grain left.

2). The platelet structure was observed in the oxygen-annealed samples. The density of platelet lines is higher at the surface area than at the interior. This result suggests that the formation of these platelets may be effected by diffusion of oxygen.