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Influence of post-annealing ambient on the superconducting properties and microstructure of $YBa_2Cu_3O_7 - \delta$ films

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Post-annealing processes are crucial for the ex-situ growth of $YBa_2Cu_3O_7 - \delta$ (YBCO) superconducting film [1]. Through annealing, the deposited atoms reorganize themselves, the amorphous precursor films transform into single crystals with orthogonal lattice structure [2, 3]. Without suitable annealing, the promising superconductive and magnetic properties can not be expected, and hence the quality of YBCO superconducting films strongly depends on the annealing parameters. Compared with in-situ synthesis techniques of YBCO [4], the post-annealing processes are more difficult to fabricate high quality YBCO films with large thickness, because the transport of reactants might be blocked by thick YBCO precursor films [5]. In order to circumvent this, we reduce the total pressure in the annealing furnace with the consideration that it could enhance the transport of reactant and then improve the quality of YBCO films. In this work, $YBa_2Cu_3O_7 - \delta$ precursor films are deposited by the co-evaporation technique using Y, BaF_2, and Cu as evaporation sources. After that, the films are annealed at low-pressure atmosphere with the composition of oxygen and water vapour. It is shown that in our experiments the superconducting properties for YBCO films with thickness larger than 500 nm has been greatly improved, and the films have smooth surface without microcrack. Moreover, the optimization of oxygen pressures is also performed, and the dependence of morphology, microstructure and superconducting properties of the YBCO films on the annealing parameters has been unveiled. Finally, it is also shown that the optimal processing window for making high quality superconducting films through ex-situ processes is relatively small, and therefore the ambient in annealing furnace should be strictly monitored and precisely controlled.

References

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