

Study on nucleation and growth of YBCO Films deposited by MOD method with in situ resistance measurement

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Abstract: The metal organic decomposition (MOD) method at reduced pressure atmosphere has been one of the most popular methods to prepare $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ (YBCO) coated conductors. The nucleation and growth processes are very important in the preparation, while it's difficult to observe the epitaxial growth of the film in direct real time. To explore these processes, a new in situ resistance measurement method is introduced to study the conductivity changes among the film growth process. The experiment results show that the conductivity of the YBCO film changes very quickly until the turning point around 730 °C. Then it becomes relatively slow above 750 °C, and gradually tends to be steady. By the way, the growth rate of different stages can be calculated by resistance formula. The SEM images and HF gas detection also proved this phenomenon. The reason is that in the early stage of nucleation, the conductivity change is dominated by the horizontal extension of the nucleation points. At turning point, the nucleation areas against base layer are attached to each other. Then longitudinal extension plays a major role in following growth. Meanwhile, in the crystallization process under total pressure of 100 Pa, the conductivity obtains extreme value in just a few minutes. While at normal atmosphere it is confirmed that the crystallization costs tens of minutes. And finally by reducing the total pressure, rapid crystallization of high performance YBCO (with J_c over $2\text{MA}/\text{cm}^2$ at 77K, self-field) has been achieved. In conclusion, by in situ resistance measurement, the optimal preparation process of YBCO films is determined, and the epitaxial growth mechanism becomes clearer.