YBCO thin films onto MgO substrate deposited by means of pulsed laser deposition

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After the discovery of the first high-temperature superconductor (HTS) $La_{1,5}Ba_{0,15}CuO_4$ with a transition temperature (T_c) of 35K by J. Georg Bednorz and K. Alexander Müller (Nobel Prize in Physics 1987), many new superconducting oxide materials were found. The most important were yttrium, bismuth, thallium and mercury based superconductors. The ceramic nature of HTS materials rules out the fabrication of bulk wires. Applications of the thin films are depend on the various substrates (mostly oxides and perovskites). An ideal deposition technique for producing such ceramic superconductor thin films is pulsed laser deposition (PLD). There are two main advantages of this technique in contrast to other thin film methods. Firstly, the simple and exact transfer of the complex target stoichiometry to the substrate. The second benefit of PLD is the small number of parameters that have to be controlled during deposition (mainly substrate temperature and oxygen partial pressure).
The aim of our research was to obtain a superconducting YBCO thin films ($T_c \approx 90$ K) with a smooth surface. Yttrium based superconductor thin films were deposited onto single crystalline MgO (100) substrate carried out using Pulsed Laser Deposition with the femtosecond excimer laser (248 nm). The deposition has performed by using variables substrate temperature, oxygen partial pressure, laser frequency, laser energy and with different kinetic of the annealing treatment after depositing (mainly cooling speed). The thin films microstructure was analyzed by means of scanning electron microscope (SEM). The energy-dispersive X-ray spectroscopy (EDS) has used to identify the chemical elements. The surface investigation was performed by using atomic force microscope (AFM). The transition temperature was recognized throughout with measurement of magnetic susceptibility as a function of temperature. Moreover we measured the most important practical parameters (critical current density) for all superconducting samples.
The results have showed that only few thin films were superconducting and mainly all had not smooth surface. Superconducting phase has found to be strongly dependent on the substrate temperature and oxygen partial pressure, moreover laser frequency and energy have discount influence on it.