MICROSTRUCTURAL ORIGIN OF THE DIELECTRIC BREAKDOWN STRENGTH IN ALUMINA: A STUDY BY POSITRON LIFETIME SPECTROSCOPY

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The dielectric breakdown strengths of two series of sintered alumina samples (of low and high impurity content, with Si being the dominant element) and single crystals are compared with positron lifetime measurements. It is found that the breakdown strength increases linearly with increasing concentration of positron traps at grain boundaries. These traps are likely clusters containing negatively charged cationic vacancies, which are induced by silicon dissolution into Al_2O_3. Therefore, the improvement of the breakdown strength can be traced to silicon segregation at grain boundaries. A solubility of Si in Al_2O_3, achieved during the firing schedule of the sintering process, and which does not take into account enhanced solubility caused by mutual compensation of Si with other lower valence foreign cations such as Ca and Mg , is estimated at 120 ppm.