Electron Microscope Study on Inclusion in Low-temperature Phase of Barium Borate (β-BBO) Single Crystal

Liu Wen (刘文) *Gao Minrong* (高闽榕) *Jiang Aidong* (江爱栋) *Chen Wenzhi* (陈文志)
(Fujian Institute of Research on Structure of Matter,
Chinese Academy of Sciences, Fuzhou, 350002)

It is well known that β-BBO is a new type nonlinear optical crystal discovered in our institute and now β-BBO is widely used in the fields of laser and nonlinear optics. However, there are still some inclusions in β-BBO crystal grown by flux method. Using AEM technique, we have studied the shape, composition and structure of inclusions which is very helpful to the explanation of the formation of inclusions.

Under optical microscope, the inclusions appear to be irregular in shape and there are some micro-cracks extending to the substrate in the boundary of large inclusions. Under scanning electron microscope, they are spongy and consist of many irregular grains surrounded by voids. The backscattered electron image indicates that the distribution of barium in the inclusion is inhomogeneous. By using electron probe micro-analysis, we studied the impurities and their distribution in the inclusions and discovered that Na element is gathered in inclusions while Ba element is much less in inclusions than in substrate. The distribution of Na and Ba is also inhomogeneous in inclusions.

Furthermore, the lattice image, structure image and electron diffraction pattern of β-BBO have been studied. The planar structure of BBO makes easy the cleavage along the *c* axis, therefore, the ground β-BBO powders are usually thin sections whose upper and lower surfaces are (001) crystal plane. The electron diffraction pattern of these thin sections is of hexagonal symmetry. The irregular inclusion grains have also been observed by electron microscope and their diffraction pattern shows diffuse diffraction rings indicating that the inclusions are amorphous.

In view of the experimental results mentioned above, we conclude that the inclusions are caused by mother liquid during the crystal growth process. As the viscosity of the melt in the growth of β-BBO is large, the transportation of solute and the exclusion of impurities are not easy. Therefore, the mother liquid is likely to enter into the crystal and when condensed to form a great number of tiny grains surrounded by voids.

Additionally, the transformation from low-temperature phase of BBO to high-temperature phase as well as the irradiation damage has also been observed in the irradiation of electron beam. This irradiation damage is more obvious when the electron beam bombards along the [001] direction. This phenomenon is associated with the planar structure of BBO.