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Microhardness and microstress anisotropy of $PbWO_4$ single crystals

I.P.Babiychuk, V.N.Baumer, V.G.Bondar, B.V.Grinyov, E.F.Dolzhenkova, V.I.Krivoshein, E.N.Pirogov, V.D.Ryzhikov

Institute for Single Crystals, National Academy of Sciences of Ukraine, 60 Lenin Ave., 61001 Kharkiv, Ukraine

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The microhardness and microstress anisotropy in $PbWO_4$ single crystals have been studied, to determine the destruction character of crystals due to mechanical action duri ng the scintillator production.

Исследована анизотропия микротвердости и микронапряжений монокристаллов $PbWO_4$ для определения характера разрушения кристаллов при механическом воздействии в процессе изготовления сцинтилляторов.

Recently, lead tungstate $PbWO_4$ (PWO) single crystals have drawn attention again due to wide use of them in scintillation engineering for high energy physics [1]. The more and more widening application of the material makes it necessary to study its mechanical properties. The growing of mechanically resistant single crystals and production of workpieces thereof is known to be difficult due to a trend to cleavage caused by anisotropy in properties of these crystals [2]. Therefore, further studies of physico-mechanical properties of these crystals, in particular, of microhardness and microstress anisotropy therein, are absolutely essential to elucidate the possible destruction character of the crystals under deformation inevitable at mechanical action on the crystal during the PWO scintillation element production. Data on anisotropy in the mentioned crystal properties are of considerable importance in estimation of many parameters of abrasive machining. The crystals behave as a rather brittle material having the cleavage plane (001), cleave easily along (101) and (112) planes under crack propagation.

The PWO single crystals used in this work were grown by Czochralski technique. Those are known to have a tetragonal structure of scheelite type with the space symmetry group $I4_1/a$ and the lattice parameters $a = 5.50$ and $c = 12.12$ E [3]. The structure base is a three-dimensional framework formed by endless zigzag-like chains of Pb eight-vertex sets connected via side edges into spirals about parallel [001] quadruple screw axes. The WO_4 tetrahedrons unbound with each other are arranged between each pair of those chains. Inside the tetrahedrons, the binding is covalent while between Pb and WO_4, ionic.

The structure data on lead tungstate published in [3] were obtained using a photo method and seem to need an refinement that has been done in this work using a PWO full-profile powder X-ray diffraction pattern measured using a SIEMENS D500 diffractometer (CuKα source, graphite monochromator in diffracted beam, scanning in the $10° \le 2\theta \le 155°$ at 0.02° steps, the accumulation duration 20 s in each point). The powder sample for X-ray examination was prepared by prolonged grinding of a PWO single crystal debris in a sapphire mortar followed by compaction in the cell using the powder mixing with an inert vola-