Crystal growth and study of rare-earth free scintillators

During two short visits to ICC-IMR together with colleagues from IMR we were focused on the search and selection of rare-earth free materials what can be used as effective scintillators and phosphors. Among variety of potential candidates divalent tungstates were selected as the most promising ones.

The high density crystals of Ca, Sr, Cd, Zn, Pb tungstates due to their high quantum yield, makes it possible to use them as phosphors and scintillators to detect both high-energy particles and low-energy radiation (medical tomography). The application of such crystals gives the possibility to decrease dramatically the production cost because of rare-earth elements absence in the crystal lattice. During many years my laboratory in General Physics Institute in Moscow, Russia, has been investigating such materials and developed single crystal growth technology by the Czochralski technique. At that time my team has succeeded to produce high quality $CaWO_4$ crystals up to 2 inch in size which were used at CRESST-II project (Europe).

Meanwhile among all divalent tungstates Cadmium tungstate shows the most interesting properties (Fig. 1) [1].

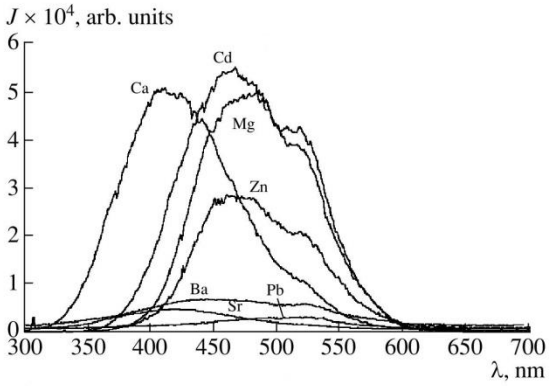

Fig. 1 Luminescence of divalent tungstates

This material has got good enough Light Yield (27000 ph/meV), short Decay Time (12 ns), high dencity (7.9 g/cm^2), and luminescence peak at 480-495 nm. However, scintillation properties of this material are very sensitive to the crystal growth conditions and after-growth treatment.

During my stay in IMR I was glad to join to the experiments for the crystal growth technology improvement with the final aim of growth of such crystals with the size up to 2 inch in diameter and stable set of parameters acceptable for the practical application. Fortunately, the students and researchers of the laboratory of Prof. Yoshikawa have got good experience in the crystal growth of different oxide scintillator crystals [2]. As a result even during my two short visits to ICC-IMR we succeeded together to grow crack-free $CdWO_4$ single crystal of 1.5 inch in diameter (Fig.2).

Fig. 2 As-grown CdWO4 single crystal

After treatment we plan to measure optical and scintillator properties of grown crystal, discuss the possible ways to improve them, and submit our results for journal and conferences. Also, we had few meetings about future experiments with the target to grow 2 inch CdWO4 crystal. Also, the possibilities to continue the search of other rare-earth free scintillator materials were discussed. Finally I would like to express my gratitude to ICC-IMR staff and all members of Yoshikawa laboratory for the invitation and help during my stay in Japan.

References

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Acta Phys. Pol. A 125 (2013) 250-264

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