Optical transmission radiation damage and recovery stimulation of DSB:Ce$^{3+}$ inorganic scintillation material

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Recently, a new scintillation material, DSB:Ce$^{3+}$, was announced [1]. DSB is obtained by standard glass production technology with successive thermal annealing. It can be produced in bulk and fiber forms with diameter up to 2mm and length up to 2000 mm. “Mother” glass is produced in the mold from the molten glass mass. Then it is subjected to annealing according to temperature program to improve its properties. Scintillation and some physical properties of the material are listed in table 1.

Table 1: Some properties of DSB:Ce scintillation material

<table>
<thead>
<tr>
<th>$\rho$, g/cm$^3$</th>
<th>Zeff</th>
<th>$X_0$, cm</th>
<th>$\lambda_{\text{max}}$, nm</th>
<th>LY, pe/MeV</th>
<th>LY(T), %/$^\circ$C</th>
<th>Averaged scintillation decay time, ns</th>
<th>Cutoff of undoped material, nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.8</td>
<td>51</td>
<td>2.6</td>
<td>440</td>
<td>100</td>
<td>0.05</td>
<td>60</td>
<td>310</td>
</tr>
</tbody>
</table>

Material can be applied to detect scintillations and Cherenkov light while it undoped. Light yield temperature dependence LY(T) is 0.05 % what is 40 times less than one of PWO. So detectors on a base of DSB will be tolerant to temperature variation of the detector modules in the range from -20 to +20$^\circ$C. It is produced from the relatively cheap but pure chemicals available at the marked.

Several samples with dimensions 15x15x7 mm$^3$ have been tested for optical transmission damage effects. It was found that induced absorption in the scintillation range depends on the absorbed dose and varies in range 3-7 m$^{-1}$. Spontaneous recovery of induced absorption has fast stage in the initial part of the kinetics. Up to 25% of damaged transmission is recuperated in 6 hours and then induced absorption remains practically stable in the samples kept in the dark. However, induced absorption is decreased in two times at the annealing at 50$^\circ$C and completely removed at the sample short annealing at 100$^\circ$C. A significant acceleration of the induced absorption recovery is observed at the samples illuminated with visible and IR light. This effect is similar to one observed in PWO [2]. It indicates that radiation induced absorption in DSB:Ce scintillation material can be retained at the acceptable level by stimulation with light at the conditions of a strong irradiation environment of the collider experiments.

Authors acknowledge Radiation Instruments and New Components LLC (Belarus) for samples for evaluation performance test of DSB:Ce for high energy physics applications.

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References