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Effect of Ti and Mg in LiF crystal and its Thermoluminescence

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Abstract

In this paper we were grown LiF single crystal and LiF:Mg,Ti by CZ methods in the laboratory. The cut pieces were exposure under γ-^{60}Co followed by thermal operation and its glow curve was investigated. Existence of F-electron trap centers belongs to pure host crystal and the role of Ti and Mg activation element was characterized as a luminescence center which is effective in enhancement of measurement sensitivity of exposure dose by TL.
Keywords: crystal growth, Czochralski(CZ), seed, thermoluminescence (TL), dosimeter (TLD),

Introduction

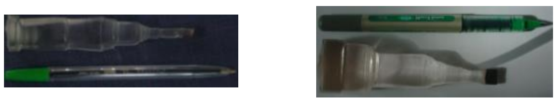
Lithium Fluoride (LiF) is among the first material which is used in thermo-luminescence dosimetry (TLD). TLD used as photon and charge particles dosimetry for individual, environmental, medical dosimetry and etc. [1]. TLD method is used generally in advanced countries in all over the world as an appropriate method for covering lots of people simultaneously. Through them LiF acts equivalent to body tissue against radiation effects, because its atomic number isroughly equivalent to body tissue (LiF atomic number is about 8.14 and body issue's one is 7.2). Also it is among the most widely used of them because of impassibility with respect to environment situation (impassibility of light and etc.) [2].Czochralski method is one of the common methods for growing alkali halide single crystals. This method is used for a half century in different countries. The crystals which grown by this method have got excellent optical properties. Also in our country this method uses for crystal growth. Required facilities for crystal growth are: furnace, crucible, seed, puller system, temperature controller, ventilation system and main material (which should have suitable purity) [3].

Etching is among methods which can express the optical quality of crystal. In this method according to the crystal type the corrosive chemical solution is chosen and the crystal is put into the solution. By this work defects sites corrosion faster than other sites. For crystals with optical application dislocation density should be between 10^4-10^6 cm^{-2} [4].

Experimental

Preparation of the materials

Pure LiF alkali halide crystals and doped LiF:Mg,Ti were grown by CZ method. First in preparation stage LiF pure salt powder, MgF_2 and TiO_2 (Merck) are weighed by specific weight ratio (According to Harshastandard [5]). Then the combination is mixed in order to uniformity. Then salt mixture is poured into the crucible and it is placed through the furnace and salt's powder is heated till 100°C upper than its melting point. After contacting seed to the melt surface, growth condition is controlled with respect to appropriate necking till minimizes crystal's defect. After necking, increasing the crystal's diameter is possible by slow cooling process to achieve to the suitable size. Figure 1 is shown pure LiF and grown crystal doped with Ti and Mg impurity.



(b) (a)

Figure 1.View of crystals (a) LiF (b) LiF:Mg,Ti(MgF_2:200ppm و TiO_2:18ppm)

Results and discussion

Grown crystals cut in line crystal planes with $3\times3\times1mm^3$ in size. Their glow curve was measured by TLD system (Harsha Model). Figures 2 and 3 belong to LiF and LiF:Mg,Ti samples, respectively.

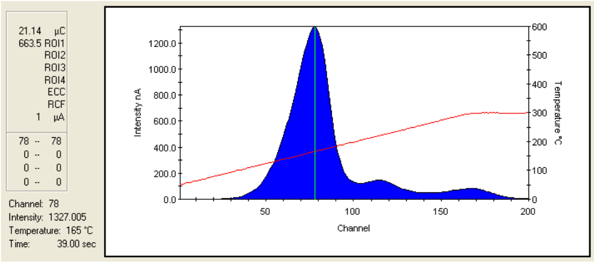


Figure 2. glow curve of LiF crystal

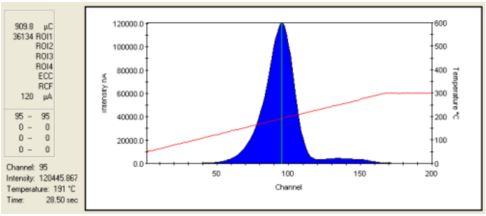


Figure 3. glow curve of LiF:Mg,Ti crystal

Table 1. Comparing of LiF glow curve doped with Mg and Ti impurity

Crystal	Under the peak area	Intensity	Temperature (°C)	Channel
LiF	21.14 µC	1µA	165	78
LiF:Mg,Ti	909.8 µC	120µA	191	95

According to comparing samples glow curve which is shown in table 1.we can say:

Under the graph area tell this subject that TLD system is counted 21.14 µC which appears with 1µA intensity (Figure 2).

Under the graph area is 909.8µC and F trap center'speak shifts to the higher temperature and its intensity is 120µA (Figure 3).

As observed, by adding Mg and Tiimpurities to LiF according to these diagrams the importance of thermo luminescence of this crystal evaluates following.

The role of Mg element in crystal lattice proposes as main trap center. Ti impurity operates as recombination center and it is effective for enhancement of TL sensitivity response [5].

Conclusions

Thermoluminescence materials are usually with impurity. So that types of trap centers and recombination ones create in them. Trap centers are able to hold released electrical charges by effect of nuclear radiation. While dosimeter is reading, heat creation causes to release saved energy by traps and detects as an emission visible light.

Mg element substitutes Li in LiF lattice, which is effective in TL phenomenon. Mg expressed as a main trap center in crystal lattice. Ti impurity acts as a recombination center and it is effective for enhancement of TL response sensitivity.

As regards we know the place of formation of TL peaks in approximation temperature (120-230 °C) is appropriate for individual dosimetry so by comparing curves can be concluded the enhancement of its radiation sensitivity to the γ ionizing radiation which is suitable in dosimetry properties.

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