Fluorescence emission from CsI(Tl) crystals induced by high-energy heavy ions

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Synopsis The fluorescence radiation from a CsI(Tl) scintillator induced by high-energy carbon ions was investigated. The structures of the emission spectra in the ultraviolet and visible bands as well as their intensity dependence on the projectile energy are reported.

Scintillating crystal is one of the most important particle detector materials, while the spatial, temporal or energy- information of the particles are probed generally by detecting the photons induced by the particles. However, there is a general lack of data on spectral components and mechanism-studies of the fluorescence emission induced by different kinds of particles.

Here in this work, the fluorescence spectra ranging from ultraviolet to visible were measured when high energy carbon ions passing though a thin plate of CsI(Tl) crystal (Caesium Iodide doped with Thallium). The experiments were carried out at the Cooling Storage Ring of the Heavy Ion Research Facility at Lanzhou (HIRFL). The sample plate was cut from the center of a big bulk of CsI(Tl) crystal made in the Institute of Modern Physics, Chinese Academy of Sciences.

For comparing, the fluorescence spectra in the same range from the same sample induced hard X-rays with energy ~50 keV were measured as well. Figure 1 shows the spectra in both cases.

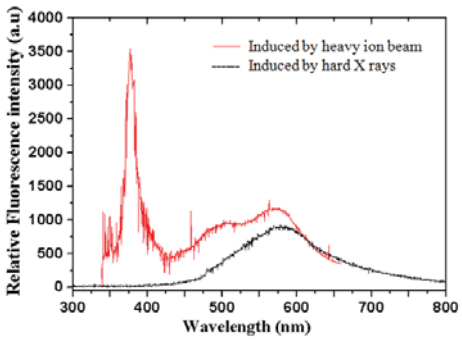

Figure 1. Fluorescence spectra in case of high energy heavy ion beam or hard X rays impacting on a CsI (Tl) crystal

It is found that the ultraviolet-band with central wavelength around 377 nm is a characteristic emission induced by the high-energy carbon ions. The ultraviolet-band emission is very intense and at the same time very sharp (with a full width at half maximum (FWHM) of about 12 nm, which is about five times lower than that of the visible-band emission). Further analysis shows that the band radiation is closely related to the doping element Thallium, even though the doping concentration is only 0.15 mol%. Due to that the ionization density induced by high energy heavy ions is much larger than that induced by X-rays or Gamma-rays, the character emission from the elements with such a low concentration could be observed [1]. This is also the reason that the characteristic emission with central wavelength around 500 nm from the very low fraction of the crystal defects was observed as well in case of heavy ion impacting [2].

It is also found that, the fluorescence intensity of each emission component increases almost linearly with the energy of the incident carbon ions which ranged from 148 MeV/u to 207 MeV/u, even though the energy deposition of the ions in the crystal decreases. The reason might be associated with the ionization density of valence electron or the fast delta electrons induced by the high energy heavy ions in the sample. More details will be represented in our coming publication [3].

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