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Fluorescence and Raman micro-spectroscopy of LiF films containing radiation-induced defects for X-ray detection

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Radiation-induced point defects, known as color centers (CCs), in lithium fluoride (LiF) thin films are successfully used in passive X-ray imaging detectors [1]. LiF film detectors for extreme ultraviolet radiation, soft and hard X-rays, based on photoluminescence of stable, laser-active electronic defects, have been proposed [2, 3, 4] and are currently under further development and investigation. LiF can be grown in the form of polycrystalline thin films and it is compatible with several substrates. These LiF film detectors are versatile and can be integrated in different experimental apparatus and imaging configurations. Moreover, the CCs photoluminescence response, which is directly related to the material radiation sensitivity, can be enhanced through the appropriate choice of substrates and multi-layer designs [5], and by tailoring the micro-structural properties of polycrystalline LiF films through the control of the growth conditions [6].
In this work we present the characterization, through fluorescence and Raman micro-spectroscopy of LiF films, thermally evaporated on different substrates with thicknesses up to 1 m, irradiated with soft X-rays produced by a laser plasma source. After irradiation, the imaging of the visible photoluminescent of radiation-induced CCs in LiF films were obtained by a confocal laser scanning microscope operating in fluorescence mode. The 2D Raman maps of the X-ray irradiated LiF films were measured by a Raman spectrometer combined with a confocal microscope that acquires a complete Raman spectrum in each point of the maps. In LiF, due to high symmetry of its fcc (face centered cubic) lattice, the Raman modes are not active at first order. The presence of defects, such as CCs, destroy this symmetry, allowing the observation of Raman spectra also at first order. The combination of these micro-spectroscopy techniques could represent an advanced method to investigate the role of the polycrystalline film structures in the CC formation efficiency at microscopic level, a fundamental aspect for the development of LiF films radiation imaging detectors.

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Summary

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