# Thorium-Doped PbS Thin Films for Radiation Damage Studies

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**Abstract :** We present a new method to produce a model system for the study of radiation damage in non-radioactive materials. The method is based on homogeneously incorporating 228Th ions in PbS thin films using a small volume chemical bath deposition (CBD) technique. The common way to alloy metals with radioactive elements is by melting pure elements, which requires considerable amounts of radioactive material with its safety consequences such as high sample activity. Controlled doping of the thin films with (very) small amounts (100-200ppm) of radioactive elements such as thorium is expected to provide a unique path for studying radiation damage in materials due to decay processes without the need of sealed enclosure. As a first stage, we developed CBD process for controlled doping of PbS thin films (~100 nm thick) with the stable isotope (t1/2~106 years), 232Th. Next, we developed CBD process for controlled doping of PbS thin films with active 228Th isotope. This was achieved by altering deposition parameters such as temperature, pH, reagent concentrations and time. The 228Th-doped films were characterized using X-ray diffraction, which indicated a single phase material. Film morphology and thickness were determined using scanning electron microscopy (SEM). Energy dispersive spectroscopy (EDS) mapping in the analytical transmission electron microscope (A-TEM), X-ray photoelectron spectroscopy (XPS) depth profiles and autoradiography indicated that the Th ions were homogeneously distributed throughout the films, suggesting Pb substitution by Th ions in the crystal lattice. The properties of the PbS (228Th) film activity were investigated by using alpha-spectroscopy and gamma spectroscopy. The resulting films are applicable for isochronal annealing of resistivity measurements and currently under investigation. This work shows promise as a model system for the analysis of dilute defect systems in semiconductor thin films.

**Keywords :** thin films, doping, radiation damage, chemical bath deposition
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