

Horizontal Ampoule Growth and Characterization of HgI₂ at Controlled Gas Pressures for X-Ray and Gamma Ray Spectrometers

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The project involves the investigation of the effect various gases, pressures, and temperatures have on the quality of HgI₂ crystals for radiation detection. The HgI₂ crystal detectors are to be used for room temperature operated gamma ray spectrometers. The project is funded by the DOE through the NEER program.

Mercuric iodide (HgI₂) is a heavy element, wide band gap (2.05 eV) semiconductor that has shown great promise as a room temperature operated gamma ray spectrometer. Its heavy element composition greatly improves photoelectric absorption for gamma rays, which is the preferred gamma ray interaction for spectrometers. Additionally, its wide band gap ensures high resistivity, thereby decreasing thermal currents and noise.

As good as HgI₂ seems at first, it does have a few problems. The material has a non-cubic crystal structure; hence the electrical properties are not uniform from one direction to another. The electrical contacts must therefore be made perpendicular to the highest resistivity plane (direction). Unlike most semiconductors, HgI₂ is highly reactive with many metals, hence only a few materials can be used as electrical contacts, usually colloidal carbon or Pd.

The most difficult problems facing widespread use of HgI₂ regard poor charge carrier transport characteristics as a result of crystal imperfections. In addition, these imperfections cause the appearance of polarization, an effect that manifests itself as a continuing change in detector signal response over time.

It has been shown in previous work that the ampoule environment, which includes temperature, gas type, and gas pressure, affects the quality of the final crystals. The *SMART Laboratory* is presently funded to study the

effects that various gases and gas pressures have on the quality of crystals for room temperature operated radiation detectors.

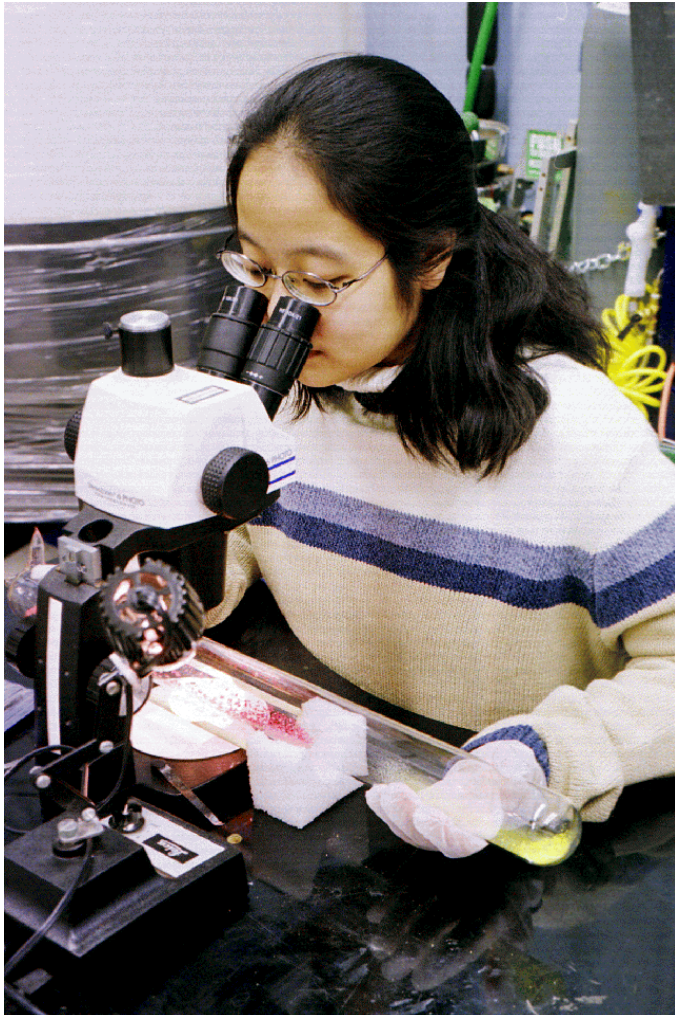


Figure 1: Elsa Ariesanti, a Nuclear Engineering graduate student at Kansas State University, inspects HgI_2 crystal platelets that she has grown with the horizontal ampoule method. The method facilitates rapid growth of small crystals, thereby allowing for a comprehensive study on how the ampoule growth environment affects the crystal electrical properties.

The program is very new, and the first crystals have only recently been grown. A variety of ampoule gases and pressures are to be investigated, which include hydrogen, nitrogen, oxygen, and some acidic gases. Each of the gases will be purified before introducing them into the ampoule. Additionally, the HgI_2 material itself will be purified to eliminate confusion regarding the starting material.

New ampoule configurations are being designed, in which a second goal of the project is to develop a method in which relatively large crystals of HgI_2 can be grown with the horizontal ampoule technique.

