

3-D mapping of tellurium inclusions in CdZnTe crystals by means of improved optical microscopy.

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CdZnTe crystals are employed for the preparation of room temperature operating X-ray detectors. High resistivity is usually reached by contemporarily doping with group III or group VII elements and using tellurium deviated charge. This latter condition is responsible for the presence in crystals of a large number of tellurium inclusions. These can be incorporated at the growing interface or can form during cooling as a result of the retrograde behavior of the liquidus curve. Unfortunately, inclusions severely limit the performances of CdZnTe-based detectors, in particular in the case of imaging devices.

This is why, monitoring tellurium inclusion density has become very important: i) for assessing the material quality ii) for studying the formation mechanisms of inclusions during growth iii) for checking the effectiveness of post-growth thermal treatments to reduce inclusion concentration.

Tellurium inclusions are typically revealed by transmission optical microscopy in the near infrared. However, determination of the concentration of inclusions is complicated by the fact that at high magnification, the depth of field is much less than the sample thickness, so that in a single photograph only few inclusions appear really sharp. In order to overcome this problem, it is possible to take a set of photographs at different focal planes and, by means of specific software, reconstruct all inclusions on a single focal plane. This technique, also provided with some commercial microscopes, suffers two main problems: i) if one inclusion is present beneath a second one, only one is detected ii) any information about the depth in the sample of each inclusion is lost.

For this reason, we have developed an instrument for the 3D mapping of the inclusions. The system is mounted on a standard optical microscope with automatic vertical movement. Pictures are taken at different focal planes. Images are then elaborated by dedicated software that ascribes each inclusion to the proper focal plane. As a result, all the inclusions are counted and precisely localized in 3D. By using the different objective lenses of the microscope is possible to tune the desired compromise between resolution and width of the monitored area. However, at high magnification it is possible to map inclusions down to 1 micron diameter. The system can be practically installed on any optical microscope that can operate in transmission mode.