Defect volumes in a conducting oxide determined from combined mechanical and electronic measurements

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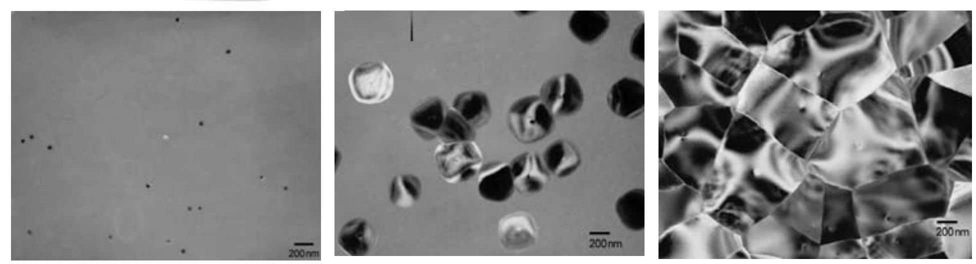
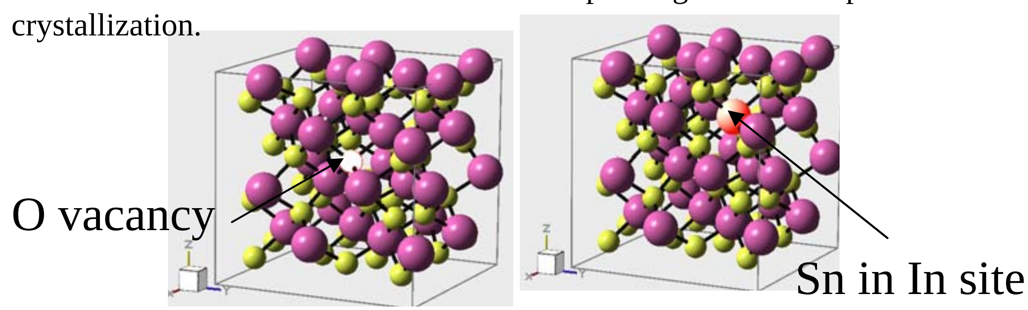
Flat panel display technology, and many other electro-optical devices, require electrode materials that are both transparent to visible light and electrically conducting. Indium-based oxides are used for this purpose because, like most thin film oxides, they are transparent but, unlike most oxides, they can also be made highly conducting. In these materials, a high concentration of free electrons --a requirement for good electrical conductivity -- can be produced by the creation of oxygen vacancies. An oxygen vacancy is formed when an oxygen atom is removed from the oxide compound. Each of these atomic-scale point defects liberates two electrons that are free to respond to electric fields. Vacancies are found in both amorphous and crystalline indium oxide both of which are of great technological importance for display technology applications. Combining mechanical measurements of film stress and electronic determination of free electron carrier density allowed us to determine the volume of a single oxygen vacancy. These point-defect data provide insight into alternative doping strategies and may lead to more versatile, lower cost, electronic display technologies.

(a) Flat panel displays require thin film material that has the ability to both transmit light and carry electrical signals. Crystalline or amorphous indium oxide doped with, oxygen vacancies, Sn, or Zn is used for this purpose.



(b) Amorphous indium oxide may spontaneously transform to the crystalline state. These transmission electron microscope images show the process of crystallization.



(c) These atomic point defects contribute electrons that are free to move through the crystal. Changes in film stress and carrier density reveal their volume.