Nanostructured ZnO Energy Generator: Influence of Dimensional and Mechanical Properties

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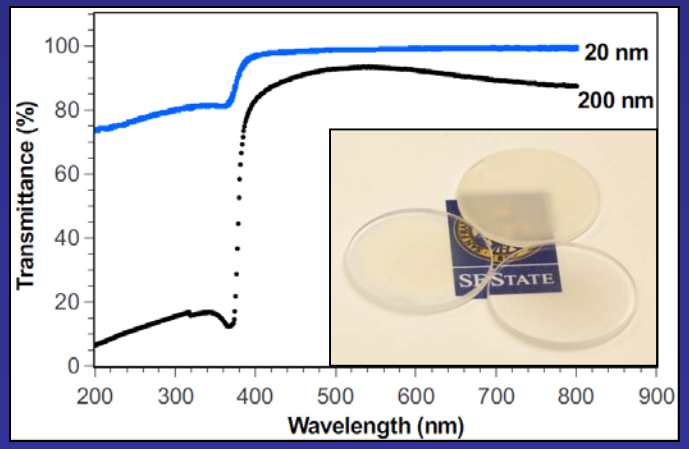
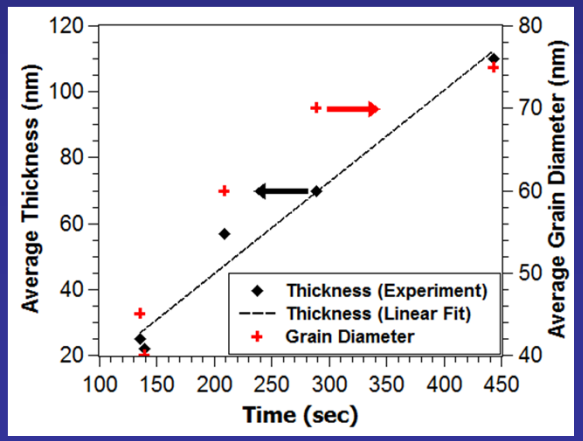
Research on energy materials is growing in importance as traditional sources of energy are becoming increasingly difficult and costly to obtain. ZnO is an important energy material inasmuch as it exhibits dual semiconducting and piezoelectric properties, making it ideal for energy harvesting purpose. To date, little is known about how ZnO's conversion efficiency and long-term reliability are influenced by fundamental properties such as dimensional and mechanical properties. In addition, time-consuming, high-vacuum and catalyst-assisted fabrication techniques also inhibit the broad applications of ZnO.

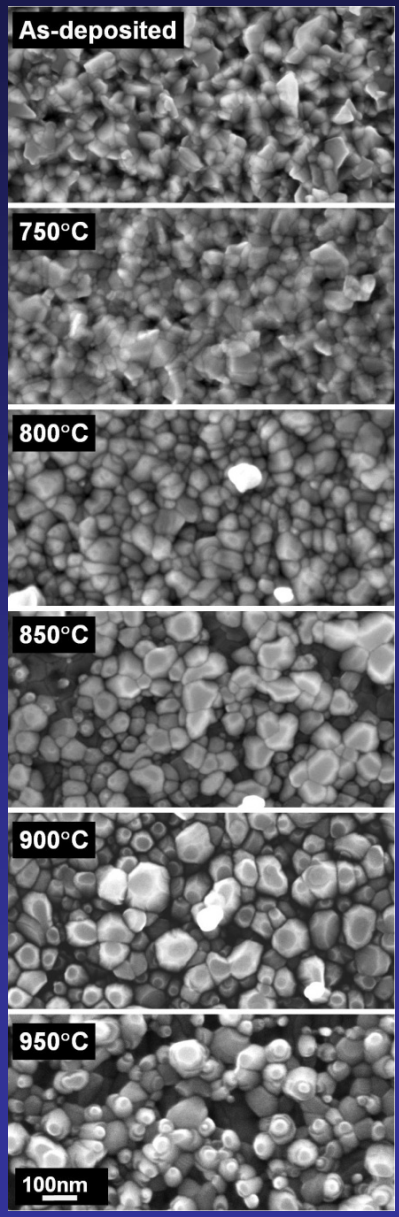
We research and develop rapid, self-catalyzed means to synthesize ZnO nanostructures and nanocrystalline thin films at near-ambient pressure. With close-looped temperature feedback control, we successfully synthesized optically transparent nanocrystalline ZnO thin films on Si(100), quartz, muscovite, sapphire, gold, titanium, and polyimide using a low-power (~100W) RF-induced inductive heating combined with thermal plasma chemical vapor deposition (CVD) process at near-ambient pressure with good thickness control. In addition, thermal annealing in pure argon shows transformation of ZnO grains into hierarchical ZnO nanorods via grain boundary and bulk diffusion.



Optical transmittance vs. thicknesses of ZnO film. (Inset, clockwise from top) 500nm, 200nm, and 20nm.



ZnO film thickness and grain size as a function of deposition time above 420℃.



Annealed ZnO Thin Films