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Mechanical Properties and Fracture of Electrophoretically Deposited CdSe Nanocrystal Films SHENGGUO JIA, SARBAJIT BANERJEE, DONGYUN LEE, JOZE BEVK, JEFFREY KYSAR, IRVING HERMAN, Materials Research Science and Engineering Center, Columbia University — The fracture, strain, and stress of electrophoretically deposited (EPD) CdSe nanocrystal films are studied as a function of the film thickness, nanocrystal size, and drying method.Fracture results from the film stress that develops with the loss of residual solvent after EPD, when the film exceeds a threshold thickness. Generational crack formation and a preferred direction for film drying are observed in real time. The elastic modulus and hardness of films of 3.2 nm CdSe nanocrystals are ∼10 GPa and 450 MPa by nanoindentation. Furthermore, after particle cross-linking and partial ligand removal, the films exhibit compaction of the nanocrystal cores suggesting these films have polymeric features that can be attributed to the organic ligands and granular characteristics due to the inorganic cores. The toughness of the thin films is determined to be ∼1000-1400 J/m^2 for channel cracks in 3.2 nm nanocrystal films; the toughness values would be lower for a (likely) sublinear dependence of stress on strain. This work was supported primarily by the MRSEC Program of the NSF under Award No. DMR-0213574 and by NYSTAR. Nanoindentation studies at the Oak Ridge National Laboratory SHaRE User Center were sponsored under DE-AC05-00OR22725.

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