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Thermal conductivity of amorphous Si and Ge thin films

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Amorphous Si and Ge films were deposited by magnetron sputtering with a laboratory-built combinatorial sputtering system at temperature of 25, 300, 500, and 600°C. The Si and Ge thin films prepared at each deposition temperature were 15, 100, and 250 nm thick. We characterized the crystalline states and microstructures of the thin films by X-ray diffraction (XRD) and high-resolution transmission electron microscopy (HRTEM). The XRD patterns and HRTEM images showed no evidence of crystallinity. We measured the thermal conductivity of the a-Si and a-Ge films by a frequency domain thermo-reflectance method. For both types of films regardless of substrate temperatures, thermal conductivity increased with the film thickness. Furthermore, in a-Si and a-Ge thin films, thermal conductivity was dependent on deposition temperature. For the 250-nm-thick a-Si thin films, thermal conductivity increased sharply as deposition temperature was increased from 300 to 600°C. However, such deposition temperature dependence was not observed in the 100-nm-thick a-Si thin films. The a-Ge thin films of 100 and 250 nm in thickness exhibit thermal conductivity dependent on deposition temperature. As deposition temperature was increased, thermal conductivity increased more strongly in the a-Ge thin films of 250 nm in thickness than those of 100 nm in thickness. We concluded the deposition temperature and film thickness dependent thermal conductivity as a result of the increase of long mean free path (MFP) phonon with increased deposition temperature, and cut off of the phonon MFP by film thickness.

Biography

Yibin Xu has completed her PhD from Shanghai Institute of Ceramics, Chinese Academy of Sciences. She is the group leader of Database group, Materials Information Station, National Institute for Materials Science. Her current research fields include modeling and measurement of thermal property of nano-scale material and material database and informatics.

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