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Phonon decay and anharmonicity in MgZnO alloys

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Embedded structural domains in MgZnO film were studied via selective resonant Raman scattering at temperatures from ambient up to 870K. The resonant conditions provided by excitation with different ultraviolet laser lines enabled the detection of longitudinal optical (LO) phonons from structural domains with the wurtzite structure, and domains with the cubic rocksalt structure which, due to alloying, lack inversion symmetry. Phonon decay channels and anharmonicities in MgZnO were studied for both structural types and phonon behavior was modeled in terms of three- and four-phonon decay processes using Ridley and Klemens type decay processes. The wurtzite phase was found to display dominantly three-phonon decay with a small four-phonon component. In contrast, the cubic phase displays a higher degree of anharmonicity, in which the four-phonon processes also contribute significantly to the temperature dependent frequency shift. At the elevated temperature range, the LO frequency shift rate is measured to be -2.6x 10^{-2} cm^{-1}/K for the wurtzite structure while that of the cubic structure exhibits a much larger temperature dependent shift of -1.6x10^{-1} cm^{-1}/K. The larger anharmonicity of the domains with the cubic structure is discussed in terms of strain and deformation effects. We acknowledge the National Science Foundation under Grant No. DMR-1202532 for their support of this research.

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