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Valley polarization and intervalley scattering in monolayer MoS_2
G. KIOSEOGLOU, University of Crete, A.T. HANBICKI, M. CURRIE, A.L. FRIEDMAN, D. GUNLYCKE, B.T. JONKER, Naval Research Lab — Single layer MoS_2 is a prime candidate material for implementing valleytronics because minima in the bandstructure at inequivalent K points of the Brillouin zone can be independently populated, thus making the valley index a potential state variable for information processing. Light of a particular helicity populates only one of the two K-valleys (either K or K') resulting in a strong emission at around 1.9 eV associated with a direct transition. We use energy and helicity dependent optical pumping to analyze the coupling of the valley and spin indices to the depolarization of emitted light. The circular polarization of the photoluminescence is very high for photo-excitation near the bandgap, and has a power-law decrease as the photo-excitation energy increases. We identify phonon-assisted intervalley scattering as the primary spin relaxation mechanism and present a model of depolarization that explains the wide variation in values for the optical polarization reported in the literature. Our results elucidate the basic processes that control the unique properties of this material and should help to realize future valleytronic applications. This work was supported by core programs at NRL and the NRL Nanoscience Institute.

G. Kioseoglou
University of Crete

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