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Dislocation spin scattering: Opportunity for Spin-Interconnects by Heteroepitaxy DEBDEEP JENA, University of Notre Dame — We develop a semi-classical theory of spin relaxation in direct-gap compound semiconductors due to Elliott-Yafet (EY) and Dyakanov-Perel (DP) scattering by edge dislocations from both charged cores, and the strain fields surrounding them. The results indicate a deleterious effect on spin transport in narrow bandgap III-V semiconductors. However, this form of scattering is found to be surprisingly benign for wide-bandgap semiconductors with small spin-orbit coupling (such as GaN). For room-temperature operation, the spin-lifetime is dominated by DP scattering from strain fields surrounding dislocations. The spin lifetime is found to be proportional to the areal density of dislocations, proportional to the third power of the bandgap, and inversely proportional to the square of the spin-orbit coupling energy. These facts point towards the fact that the spin lifetime can be considerably enhanced by using a wide bandgap semiconductor layer with small spin-orbit coupling, grown heteroepitaxially on a narrower gap layer such that there is an appreciable density of dislocations. The III-V nitride semiconductors, particularly GaN, is well suited for such spin-transport layers, and should be considered for spin-interconnects in the future. Thus, lattice-mismatched hybrid heterostructure devices can simultaneously take advantage of the long spin lifetimes of the wide-bandgap semiconductors and the wide tunability of spin in the narrow-bandgap semiconductors for spin logic-operations.

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