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Strongly localized isoelectronic impurities for synthesizing novel semiconductor alloys

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Isoelectronic impurities whose electronegativity and size are very different than the host atom; the substitute can introduce resonant states in either the conduction or valence band that induce substantial changes in the electronic band structure. Nitrogen is well known to create a resonant state above the conduction band minimum that causes band mixing and a 180 meV/% N drop in the bandgap energy. Bismuth also produces a similar effect in the valence band of GaAs that leads to a bandgap reduction of 88 meV/% Bi. This strong dependence of the bandgap energy on the alloy composition makes both $GaAs_{1-x}N_x$ and $GaAs_{1-x}Bi_x$ alloys potentially important materials for high efficiency multi-junction solar cells, infrared lasers, LEDs and detectors. Moreover, they provide rich systems for exploring the interaction of localized states dispersed throughout a host matrix. Statistically occurring N pairs and clusters strongly localize electrons in the bandgap, while analogous Bi-related states localize holes. These states can then be made to interact by increasing their concentration. For example, wavefunction overlap between localized N pair states creates delocalized superclusters that further perturb the host GaAs electronic structure. Application of a magnetic field can then be used to reduce the Bohr radius of excitons bound at these states, fragmenting the superclusters. The investigation of such phenomena provide insight into the evolution of localized impurity states into delocalized alloy states and shed light on the birth of novel semiconductor alloys.

Biography

Kirstin Alberi received a BS in Materials Science and Engineering from the Massachusetts Institute of Technology in 2003 and a PhD in Materials Science and Engineering from the University of California, Berkeley in 2008. She is currently a Senior Staff Scientist at the National Renewable Energy Laboratory, where she conducts basic research on the epitaxy of novel semiconductors and heterostructures and studies the optical and electronic properties of semiconductor alloys for photovoltaic and solid-state lighting applications. She also serves as a Member of the Editorial Board of *Journal of Physics D: Applied Physics*.

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