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Investigating high-temperature operation limitations in antimonide-based mid-infrared semiconductor lasers

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Abstract

Scientists are pursuing a variety of semiconductor systems to generate mid-infrared (3-5 μm) laser radiation for applications in environmental monitoring, homeland security, and medical diagnostics through the development of efficient, portable chemical sensors, infrared countermeasures, and breath analyzers. Antimonide-based heterostructures that employ an indirect type-II quantum well configuration have proved to be a very promising approach in this wavelength range, with notable recent advances in interband cascade lasers. However, there remain challenges in this system in achieving excellent performance at high operating temperatures. To develop practical mid-infrared chemical sensors that operate at ambient temperatures with low power requirements, it is critically important to reduce the rate at which the lasing thresholds rise as a function of increasing temperature in these materials; at present characteristic temperatures plateau around 60 K. Recent results in optical pumping of type-II antimonide-based semiconductor lasers with W-shaped quantum wells will be presented, as will new projects employing electrically injected interband cascade lasers as well as semiconductor lasers with integrated graphene transparent contacts. These projects have a common theme designed to reveal the optoelectronic mechanisms that limit high temperature operation in antimonide-based type-II W lasers, with a particular focus on increasing the characteristic temperature of these materials and devices.

Biography

Linda Olafsen completed her Ph.D in Physics at Duke University in 1997, followed by a National Research Council postdoctoral research associateship at Naval Research Laboratory in Washington, D.C. While on the Physics faculty at the University of Kansas, she received an ONR Young Investigator Award in 2001, and she has been an Associate Professor of Physics at Baylor University since 2006. She currently chairs the Book Review Board for the MRS Bulletin and is Chair of the Congressional Visits Day subcommittee for the Materials Research Society, and she is a member of the GRE Physics Committee of Examiners