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INDIUM MAKES MORE DURABLE SEMICONDUCTOR LASER: A strong case has been made for replacing aluminum-based semiconductor lasers with a new indium-based type that researchers at Northwestern University have been working on (*IR&D*, Dec. 8, 1993, p. 4). In fact, the durability of the new semiconductor diodes is enough better than those in present high-power lasers that we could see a search for new applications of near-infrared diode lasers. Expected lifetime of the indium-based lasers is 10^5 hr to 10^7 hr, compared with 10^4 hr to 10^5 hr for aluminum-based lasers.

When you get into high-powered solid-state lasers, you need to have a way to excite or pump the laser by light of the appropriate wavelength. You can do it with conventional gas-discharge lamps, but semiconductor diode lasers are more compact and efficient. The trouble is that the material of choice for these alloys of aluminum, gallium and arsenic (AlGaAs) have short useful lives: The aluminum interacts with oxygen, forming oxide at the mirror facet, enhancing the nonradiative recombination of nearby injected carriers. The mirror overheats and the lifetime of the device is decreased. Life is also limited by the formation of dark line defects, as dislocations form in the active region during high-power operation spread.

Northwestern University scientist Manijeh Razeghi sees a way out. Use diode lasers made of InGaAsP, a material similar to the AlGaAs now used, but in which the aluminum is replaced by indium and phosphorous. InGaAsP laser diodes show significantly improved reliability, yet their electrical and optical properties are as good as or better than those of AlGaAs diode lasers.

Nonradiative recombination velocity near the mirror facet for InGaAsP is at least two orders of magnitude less than for AlGaAs. Dislocation mobility is much less. Other advantages are seen: Selective etching and regrowth (essential for laser-diode fabrication) is possible. Absence of surface oxidation facilitates regrowth of chemically etched *mesa*-structures and gratings, eliminating AlGaAs oxidation problems. Laser-quality material should combine close lattice-match to the substrate with excellent radiative and electrical properties.

In preliminary life-testing, InGaAsP lasers with uncoated facets emitting at 0.808 μ at 40 C performed for more than 1000 hours without degradation -- and are still running continuously, still without degradation. Reliable high-power InGaAs/GaAs/InGaP single quantum well lasers emitting at 0.98 μ were also grown by low-pressure metal organic chemical vapor deposition (LP-MOCVD; a widely used way to make semiconductors). Threshold current density as low as 80 A cm^{-2} and differential efficiency as high as 75% were observed for 1-mm-long coated lasers. Device lifetime at 50 C exceeded 2000 hours at 1 W output with degradation less than 20% -- and it's still running. Patent applications have been submitted for the indium laser and move toward commercialization will be swift, probably happening in 1996 or 1997.

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