



## AN-15 LASER DAMAGE FROM BACK-REFLECTIONS

High-power multimode laser diodes can suffer damage or shortened lifetime from optical feedback to the laser chip. This problem is more likely to occur in very high-power or high-power-density laser diodes. Red laser diodes in the 6XX nm range seem to be especially sensitive to back-reflections, compared to IR lasers.

It does not take very much optical feedback into the laser chip to cause problems. Just a few percent of the reflected light back into the laser chip is enough to cause lifetime issues. But diffuse or divergent reflections are unlikely to cause problems. The kind of reflection that is a problem is a reciprocal reflection, that is, light reflected directly back into the laser chip through the collimating/focusing optics. This situation is commonly encountered when using a lens to focus the light from a laser diode into an optical fiber. If the end face of the optical fiber is perpendicular to the input beam, the 4% reflection from that end face can travel directly back through the focusing lenses into the cavity of the laser chip. This kind of reciprocal reflection, even though small, can destabilize the laser cavity and cause laser diode failure or shortened lifetime. To prevent this problem, the end face of the optical fiber is typically angled ~4-8 degrees so that the reflection will not travel directly back into the laser diode cavity.

This problem can also occur in any situation where the laser light is focused to a spot on a surface at normal incidence, for example, when lenses are used to focus light onto a spot during the pumping of a solid-state laser crystal. Again, the solution is to angle the input surface of the laser crystal so that reflections do not return directly into the laser diode cavity. If necessary, the pump beam axis can be offset slightly from the laser cavity axis, so that refraction at the air/crystal interface brings the pump beam back into alignment with the laser cavity axis.