The Nd:YAG Laser: Bringing coherence to Prometheus’ gift

Randall McPherran, O.D.

The first visible-light, solid-state laser was invented in 1960 by Theodore Maiman, utilizing a chromium doped ruby rod crystal. The laser utilized a helically shaped xenon pump lamp, which surrounded the crystal to excite electrons of the Cr3+ ions into a higher-order state.¹ When the stored energy reached resonance, the process of stimulated emissions would occur.¹ Within two years, the concept of Q-switching (the interruption of the emissions by the use of electrical shutters allowed the recharging of the doping ions to the higher-order states) produced enormous power increases in the form of a giant pulse formation.

In 1964, the most useful and widely used (particularly from a medical point of view) solid-state Nd:YAG laser was invented. In this laser, the dopant is triply ionized neodymium (approximately 1 percent by atomic weight) which replaces the yttrium substrate ions. As with the ruby rod laser, the Nd:YAG lasers are optically pumped using flash tubes or diodes. With high output power and pulse durations measured in nanoseconds, the Nd:YAG laser may be efficiently frequency doubled to operate at 532 nm.²

In Q-switched mode the Nd:YAG laser is photodisruptive by producing acoustic shockwaves generated by ionization and plasma formation.¹ Among its many medical applications, the Nd:YAG laser has myriad of ophthalmic uses, including:

- Posterior capsulotomy¹,³
- Anterior capsulotomy
- Laser peripheral iridotomies (LPI)
- Vitreolysis
- Selective laser trabeculoplasty (SLT)⁴⁻⁶
- Corneal stromal reinforcement

One of the most common ocular applications of the Nd:YAG laser is in posterior capsulotomies. It has been estimated that 20 to 30 percent of cataract surgery patients will experience posterior capsule opacification to the extent of needing laser intervention³,⁷⁻¹¹ The prevalence rate for retinal detachment within three years after non-complicated cataract surgery has been reported to be 1.9 percent averaged across multiple studies.³,⁷⁻¹¹ It has been stated that there is a four-fold increase in retinal detachment for those requiring YAG capsulotomy as compared to uncomplicated cataract surgery without capsulotomy. While the cause is unclear, it has been proposed that it may be related to the propagation of shockwaves into the vitreous.

References:


Dr. McPherran is an Associate Clinical Professor and serves as Chief of UC Berkeley Eye Services at Castle Family Health Center. He is a Fellow of the American Academy of Optometry and has served as past chief examiner to the National Board of Examiners in Optometry. He is a frequent lecturer at the American Academy of Optometry, Ellerbrock Lecture Series.

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