Solid State Dye Laser

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Dye lasers use an organic dye as the lasing medium. Using organic dyes, we can produce a tunable laser for a wider range of wavelengths. Using different optical equipment, we can isolate and choose the specific wavelength we want. The dye is usually in a liquid form which makes changing the dyes both messy and harder to dispose of once the medium is exhausted. By putting the liquid dye into an acrylic disc, we can make changing dyes both less time consuming and safer for disposal.

My research is in solid state dye lasers using Rhodamine 6G for the organic dye. The primary goal of this research is to design a way to put the dye in a solid medium. The main reason for performing this research is to make the changing out of the dye in the laser faster and cleaner as liquid dye is hard to flush out of the system effectively. The other goal of this research is to develop a method of effectively oscillating the discs to maximize the useful area of the disc. Ultimately we want a stable, high power, narrow bandwidth tunable laser.

Abstract

To produce the dye discs, I mixed a solution of 0.46 grams of Rhodamine 6G and 100 mL of methyl methacrylate to completely saturate the solution, then added a hardener and poured the solution into a cylinder with a 50mm diameter. Plastic wrap was placed over the top to prevent the solution from evaporating and placed under a black light to harden the solution into a cylinder.

After curing the cylinder, the cylinder is placed in a lathe and cut into the discs and polished using an automated polisher, increasing the grit until optical clarity was achieved.

Dye Disc Production

Disc Oscillation

This dye laser is optically pumped by a frequency doubled Nd:YAG Laser (532nm, green). Initially I built an oscillating system using magnetic coupling to minimize mechanical vibration in the oscillating system. The mechanical vibration from using a direct contact motor on the air bearing was causing the disc to impact the sides of the housing and make the disc skip. By using magnetic coupling, the air bearing moves back and forth to avoid direct contact.

This created a problem since the ends of the oscillating path caused the dye disc to spend more time at the ends of the disc and exhaust the dye material unevenly which in turn caused an uneven output.

To construct the dye Laser, we started with the 532nm ND:YAG pump Laser, a beam splitter dumps half of the output power of the pump laser so the dye discs do not fatigue too quickly. The pump beam is focused on the dye disc. The disc lases at a new, longer wavelength which is controlled by a cavity consisting of 2 mirrors and a diffraction grating.

Further research

The next stages of research I would like to work on is a new method of oscillating the disc using a rail system. The dye disc housing will be attached to a motor that will move the housing in a circular motion. The rail will be attached to the optical table at one end which will cause the disc to move up and down as the housing is moved left and right. This will cause a rotating circular pattern on the disc which will prolong the life of the dye disc and cause a more even wearing.

New mediums for the dye will also be looked into such as aerogels and acrylic.

I would also like to set up an amplifier for the unknown wavelength using a second oscillating dye disc and using the second half of the dumped 532nm laser from the first beam splitter for higher energy output.