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An Aluminum Coated Pyrex Double Ellipse Laser Cavity

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Abstract

A method for constructing a pyrex double ellipse laser cavity is described. When the aluminum coated reflecting surface is used in a flashlamp pumped dye laser, considerable improvement in the power output is noted.

Many successful flashlamp laser pumping schemes rely on a multielliptical configuration where the gain medium is placed at a common focus of two or more cylindrically symmetric ellipses. Although single flashlamp cavities are generally more efficient, two or more flashlamps give more even pumping and consequently an inherently better mode structure. Also, several lamps distribute the energy load and allow for both higher pump energies and longer lamp lifetimes.

The flashlamp cavity we present in Fig. 1. is essentially the same design as the Zeiss-Lambda Physik dye laser double elliptical cavity.[1] However, the Zeiss polished aluminum reflector is replaced by a Pyrex double ellipse, and the ellipse has a thin film of vacuum-deposited aluminum on the outside surface with an outer layer of paint applied to protect the coating. There are several advantages to this cavity design. Since aluminum evaporated onto a glass substrate has a significantly higher reflectivity than polished aluminum, especially in the near UV spectral region, the optical coupling of the lamps to the dye cuvette is increased. Furthermore, a polished reflector is attacked by water which may be ionized by the intense UV light from the flashlamps. (Water floods the cavity to cool the flashlamps and act as an index-matching fluid between the quartz envelope of the lamps and the dye cuvette.) After several million pulses, the output power of a polished reflector dye laser drops by more than a factor of two if the aluminum is not repolished. On the other hand, the Pyrex reflector is a back surface mirror and is completely immune to this deterioration. Also, Pyrex begins to absorb radiation around 300nm and serves as an effective filter for the harder UV that is generated by the flash-lamps so that the dye lifetime is expected to increase substantially.

The most attractive feature of a Pyrex ellipse reflector is the ease with which it can be mass-produced economically. It is constructed by first milling a two-piece AFT graphite mold that is hinged together as shown in Fig. 2. The parameters of the ellipse were chosen so that it could be cut from a 1" end mill cutting 32° from the horizontal. The mold is first heated by a standard laboratory bunsen burner, and then a softened 28 mm dia. piece of Pyrex tubing is quickly placed in the center of the carbon form. Before the tubing hardens, the mold is closed and the tubing is gently blown out. The outer reflecting surface of the ellipse can be made accurate to a few thousandths of an inch, and four such ellipses were made in roughly 15 minutes. The ellipsoid tubing is then annealed, cut to the proper dimensions and coated. There are slight undulations on the inner surface of the ellipse, but the index-matching water that floods the cavity greatly reduces the optical distortion. The outer surface of the Pyrex is remarkably smooth since the glass is never in a completely molten state and consequently does not acquire the tiny imperfections of the graphite form.

We have found that the Pyrex double ellipse substituted for a freshly-polished aluminum reflector increases the output power of an R6G dye laser by roughly 50%, despite the UV filtering. With a sparkgap discharge of a .2μF capacitor, and the flashlamps (4" long, 3mm bore, ILC #2339) operating in simmer-mode[3] and prepulsed[4,5], modest pumping energies of 10 joules/pulse yield a broadband laser output of ≃ 20mj/pulse with a full angle divergence of ≃ 1.5mrad in a cavity one meter long. At these low pump energies, the lamps last an average of 5×10^6 shots at 10-15 pps.

We thank glassblowers Morley Corbett and Dane Anderberg for their advice and assistance.

References

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[2]J. Jethwa, F.P. Schafer, Appl. Phys. 4, 299 (1974).

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Figure Captions

Fig. 1. Cross-section of the laser head. The Pyrex ellipse is made leak tight with RTV sealing to the outer surface so that the adhesive is not exposed to the intense UV light of the flashlamps.

Fig. 2. Photograph of the graphite mold and a finished aluminized ellipse.

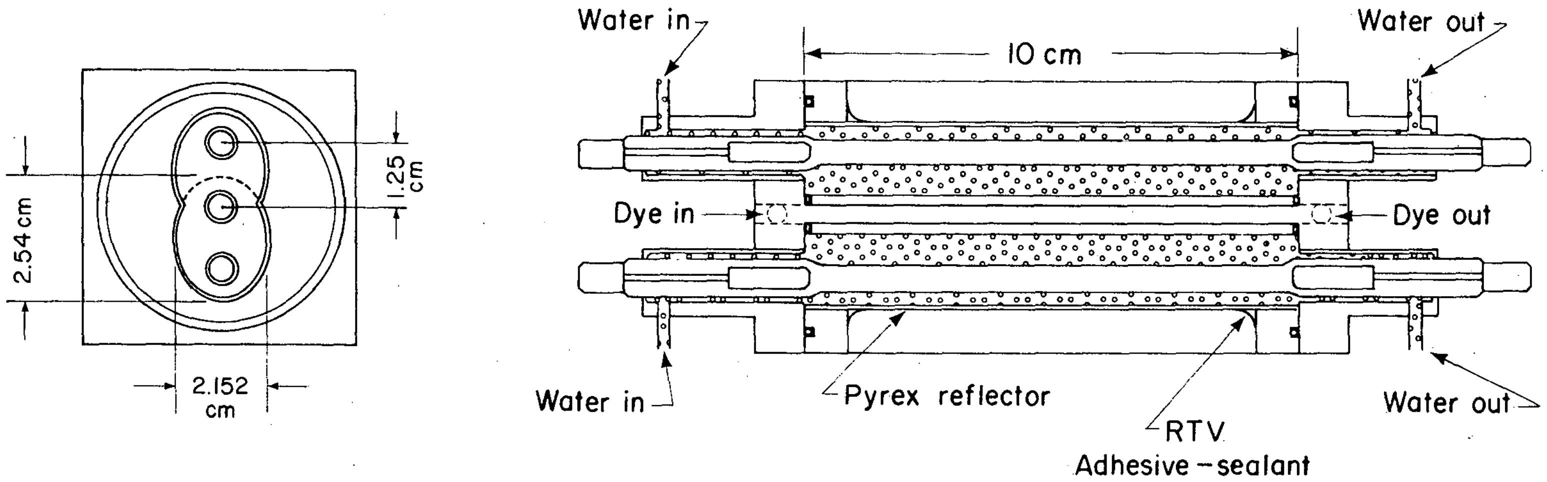

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Fig. 1

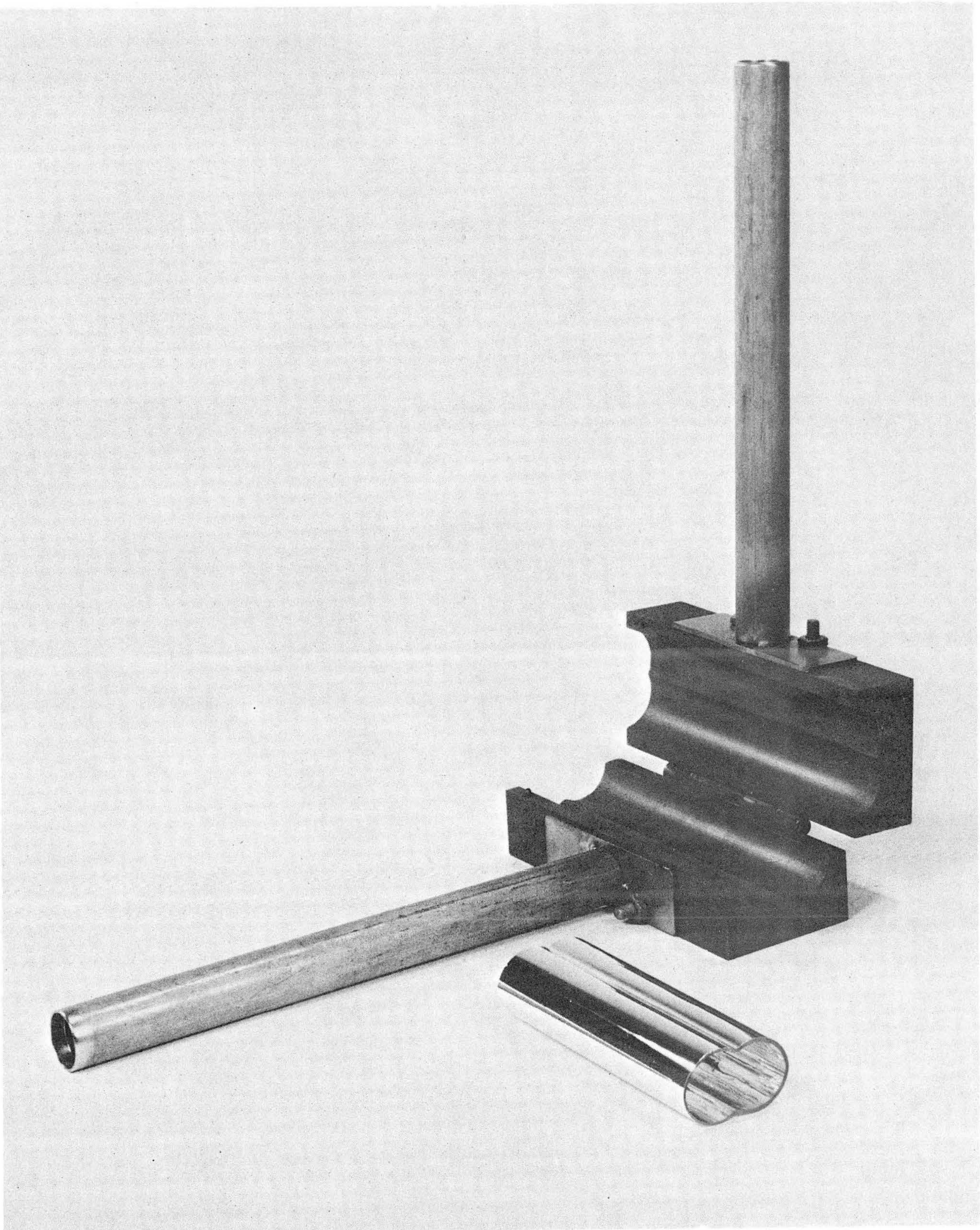

Fig. 2 XBB 7612-11541

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