## ⑤ Interferometers Using Inexpensive Laser Diodes

The party line has tended to be that the coherence length of diode lasers is too short for interferometry or holography. (See the sections beginning with: General Interferometers.) While I was aware of CD laser optics being used with varying degrees of success for relatively short range interferometry (a few mm or cm - see the section: Can I Use the Pickup from a CD Player or CDROM Drive for Interferometry?), the comments below are the first I have seen to suggest that performance using some common laser diodes may be at least on par with that of a system based on a typical HeNe laser (though not a high quality and expensive frequency stabilized single mode HeNe laser).

While I don't know how to select a laser diode to guarantee an adequate coherence length, it certainly must be a single spatial (transverse) mode type which is usually the case for lower power diodes but those above 50 to 100 mW are generally multimode. So, forget about trying to using a 1 W laser diode of any wavelength for interferometry or holography. However, single spatial mode doesn't guarantee that the diode operates with a single longitudinal mode or has the needed stability for these applications. And, any particular diode may operate with the desired mode structure only over a range of current/output power and/or when maintained within a particular temperature range.

(From: Steve Rogers (scrogers@pacbell.net).)

I have been involved with laser diodes for the last 15 years or so. My first was a pulsed (only ones available at that time) monster that peaked 35 watts at 2 kHz with 40 A pulses! It was a happy day when they could operate CW and visible to say the least. Anyway, in the course of my working travels, I have built numerous Twymann-Green double pass interferometers for the wave front distortion analysis of laser rods, i.e., Nd:Yag, Ruby, Alexandrite, etc. The standard reference light source for this instrument has always been the 632.8 nm HeNe laser. Good coherence length and relatively stable frequency was its strong suit.

When visible diode lasers came out I often wondered aloud about their suitability as a replacement for the HeNe. I despise HeNe lasers. They are bulky and I have been shocked too many times from their power supplies.

I assumed that since CD player laser diodes at 780 nm could have coherence lengths on the order of tens of centimeters or into the meters (!!, see, for example: Katherine Creath, "Interferometric Investigation of a Diode Laser Source", Applied Optics (24 1-May-1985) pp. 1291-1293), Visible Laser Diodes (VLDs) could make excellent replacements. As it turned out, VLDs tend to have coherence lengths which are considerably shorter according to the latest technical literature and I held off on experimenting with them. Last week, I went through my shop and found enough mirrors, beamsplitter, assorted optics to throw together my own double-pass interferometer for home use. This coincided with my acquisition of a 635 nm 5 mw diode module - a good one from Laserex.

To make a longer story shorter, I assembled said equipment with the VLD and WOW! excellent fringe contrast (a test cavity of four inches using a .250" x 4.0" Nd:Yag rod as the test sample.) When a HeNe laser was substituted for the VLD, virtually no difference in the manual calculation of wave front distortion (WFD) and fringe curvature/fringe spacing. The only drawback with the VLD is that it produces a rectangular output beam. When collimated you have a LARGE rectangular beam rather than a nice round HeNe style beam. My interferometer now occupies a space of 10" x 10" and is fully self contained. It probably could even be made smaller. Not only that, but it runs on less than 3 V!!!

I am just as surprised as you are with the results that I achieved. This is one reason why it took me so long to attempt this experiment (something like 4 to 5 years). I have always assumed that a HeNe laser would be FAR superior in this configuration than a VLD would be. Perhaps others may know more about the physics than I do. One thing is certain, these are "single mode" index guided laser diodes and typically exhibit the classic gaussian intensity distribution which is not so evident with the "gain guided" diodes. This in turn implies a predominant lasing mode which in turn would imply a (somewhat) stable frequency output. Purists would note that this VLD has a nominal wavelength of 635 nm +/- 10 nm while the HeNe laser is pretty much fixed at 632.8 nm. This variable could account for extremely minor WFD differences.

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There's an outfit in Israel selling a diode based laser interferometer enough cheaper than Zeeman split HeNe units to suggest that they are using a laser diode in the 'CD player' class, or perhaps a little better. They are able to measure, 'single pass' (retro rather than plane mirror) over lengths of up to about 0.5 m, suggesting that as an upper limit for coherence length.