

October 08, 2010

Red fiber laser

Playing around with red fiber laser. In particular, I want to become familiar with the numbers involved.

References:

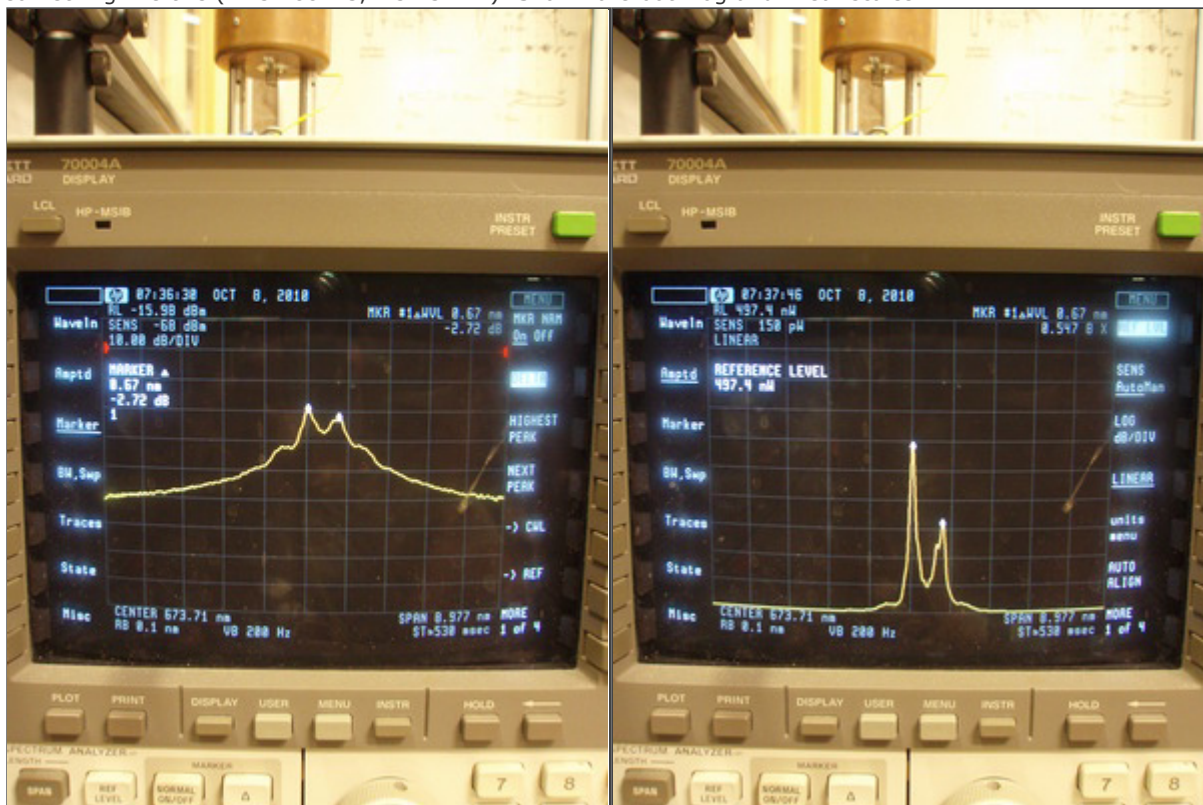
- Wieman's 1990 review on diode lasers
- Pigtailed laser (Thorlabs)

[Peter]: I suspect that the spacing of the fringes corresponds to the FSR of the laser diode. It is likely that what you are seeing is the laser being multimode and modehopping. This is probably due to optical feedback and good isolation will definitely help. You will also find that it will not lase single mode for all combinations of current and temperature.

[ike]: The HP70951A has a resolution of something like 0.08nm

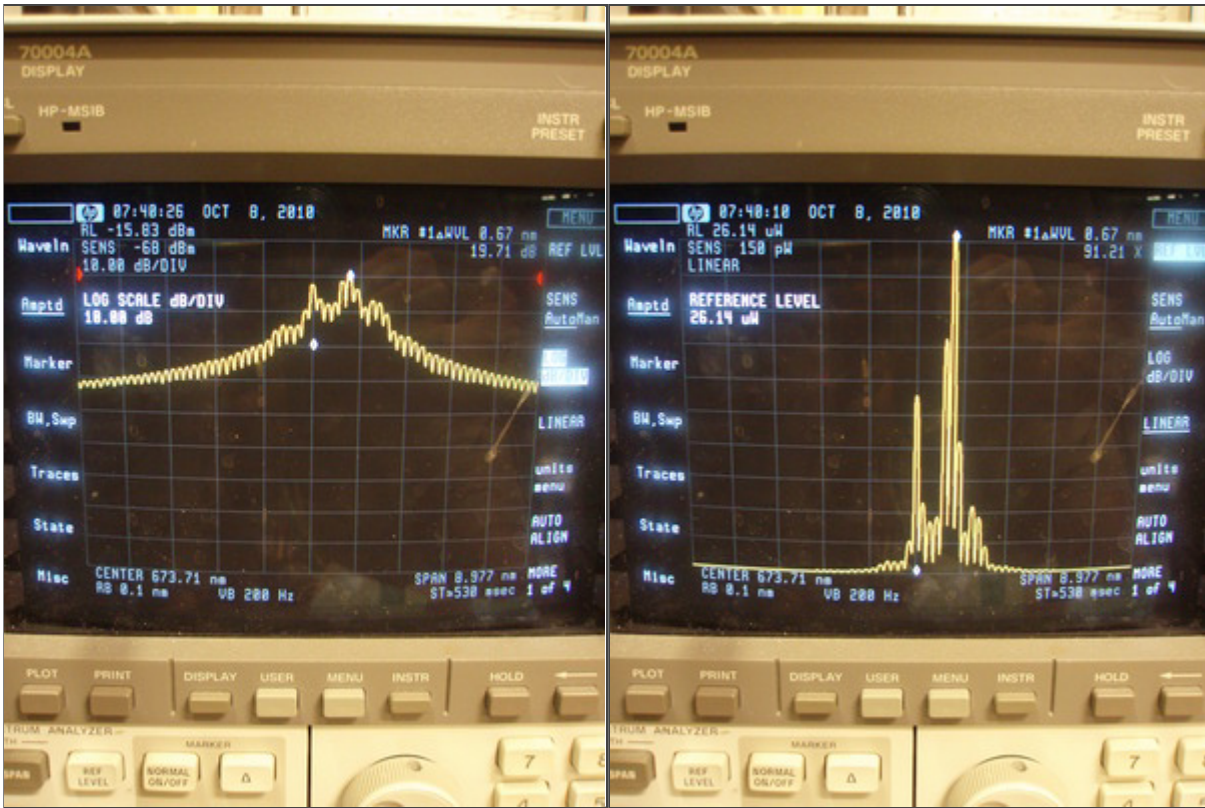
To begin, I want to familiarize myself with the properties of the bare diode (+fiber) with no injection light. I want to observe for myself the wavelength change as a function of temperature, and want to observe modehopping. I would also like to investigate the effect of unwanted optical feedback.

First, just to get used to the measurement apparatus. I put reasonably weak light (by inspection maybe few 10s of uW or less) out of the laser's fiber directly into the HP70951A optical spectrum analyzer (600-1700nm). The initial profile looks something like this (T=32.88°C, I=31.57mA). Shown are both log and linear scales:



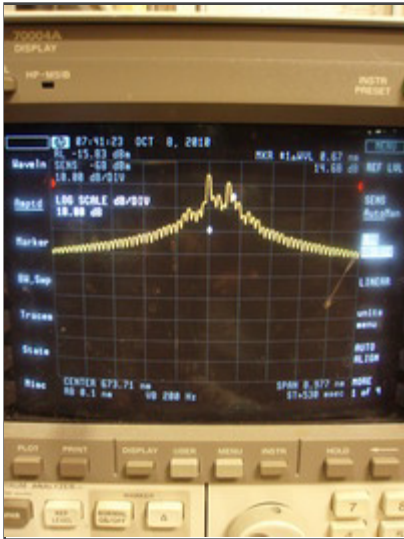
The laser center frequency is in the vicinity of 674nm. The separation between the two peaks is 0.67nm as shown by the cursors in the above pictures.

The output facet of the fiber is PC/FC. To get the spectra as shown in the above two pictures, I *very weakly* connected the fiber to the spectrum analyzer input. When I couple the fiber very strongly, I find the following spectra:



The spacing between the new, tight fringes is 0.124nm.

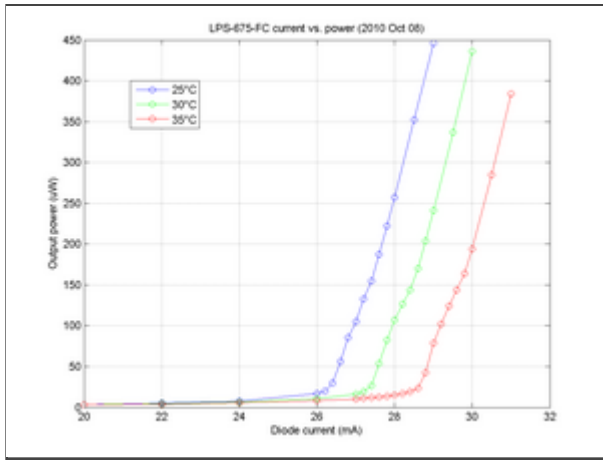
I can also get a slightly different looking spectrum by wiggling the connector:



Let me see if it is possible to avoid this effect by going through an isolator.

My current setup is very conducive to measuring the current-power characteristic of this diode. Let me do just that.

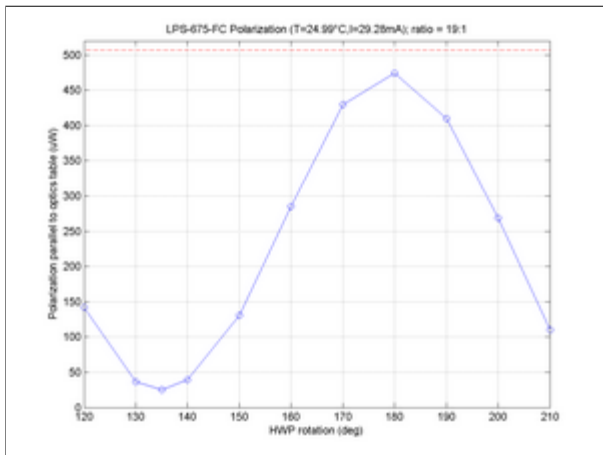
Corroborated what is noted in the Wieman paper, that the diode is more efficient (electric to optical power) at lower temperatures:



I will do the isolation testing with 500uW of power at 25°C. Operating point is ($T=25.04^{\circ}\text{C}$, $I=29.28\text{mA}$).

Despite the SM fiber, the laser output seems to be significantly polarized. I find that 450uW/500uW makes it through the isolator. Let me check this independently.

Checked polarization independently by using HWP and analyzer PBS. Found a high degree of polarization. Ratio is $475:25 = 19:1$.



However, the polarization also seems to be unstable if I stress the fiber, for instance (which I avoid in the HWP measurement). The effect is actually pretty clear. Depending on how I stress the fiber, different amount makes it through the isolator.

(Found that the fiber splitter is an extremely handy tool for initially setting up fiber coupling!)

After noting the stress effect, I wanted to keep the area somewhat organized so that I do not continue to change the fiber laser polarization by accident. In searching for items, found a fiber paddle. I set this up, which keeps the fiber nicely packed away, and also allowed me to modify the polarization to pass the isolator.

Coupled light into fiber after isoлятор. Sent in 500uW to the monochromator. Found the following:

- 1) The 0.133nm fringes are still there,
- 2) Peak center wavelength($T=24.99^{\circ}\text{C}$, $I=29.89\text{mA}$) of 672.5nm
- 3) FWHM of $\sim 0.087\text{nm}$. That's like 60GHz? That's way higher than what Jarek claims as the "Schawlow-Townes" limit. Maybe it's an instrument error? (I will measure the linewidth of the monolaser 674nm with the apparatus to see.



The nature of the fringes are still to be determined. Perhaps they are the remanant of stil having the FC facet and the PBS of the isolator in front? I find, at least, that playing around with the fiber connector to the monochromator input (after isolator) only seems to scale the optical power, but not the spectral distribution.

Let me now log the laser wavelength as a function of temperature. (Actually, continue tomorrow.)

Posted by kimt at October 8, 2010 09:21 AM

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