# Investigation of self-wavelength sweeping in thulium-doped fiber ring laser

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The phenomenon of self-wavelength sweeping in bi-directional thulium-doped fiber ring laser is investigated in this paper. The laser wavelength can sweep at a rate up to 0.2 nm/s over 13 nm range in the 1950 nm region spontaneously.

An external cavity laser (ECL) at 1570 nm amplified by an erbium-doped fiber amplifier (EDFA) is used as the pump source for the thulium-doped fiber laser. A 2.5-meter-long thulium-doped fiber is connected to the laser cavity through wavelength-division-multiplexing (WDM) fused coupler. A 20:80 four-port optical fused coupler is employed for the bi-directional output. There is no optical isolator inside the cavity in order to enable bi-directional operation, while optical isolators are used at the output ports to block unwanted reflection. The laser output spectra depicted in Fig. 1. In practice, once the pump threshold is satisfied and the polarization is adjusted properly, the lasing wavelength keeps drifting continuously to the short wavelength away from the initial laser wavelength (e.g. from 1957 nm to 1944 nm), then suddenly returns to the initial lasering wavelength after reaching the shortest wavelength. The temporal behavior is shown in Fig. 2. Microsecond pulse train with frequency of about 100 kHz is recorded. This is attributed to the relaxation oscillation of the active fiber, since each of the longitudinal mode lasts only for a limited time.

The mechanism can be analyzed by mode-coupling between clockwise (CW) and counter-clockwise (CCW) modes[1]. In the case of self-sweeping, the CW and CCW modes create a standing wave in the active fiber, which will induce a spatial variation in terms of gain saturation. The current lasing wavelength will be less preferred because of the saturation[2], hence lasing will toward a drifted wavelength with a higher gain, and this sustained mechanism initiates the sweeping phenomenon.

The investigation reveals the impact of mode-coupling theory on laser output behavior, we believe that it is helpful for research on bi-directional fiber laser and fiber ring laser gyroscope (FRLG).

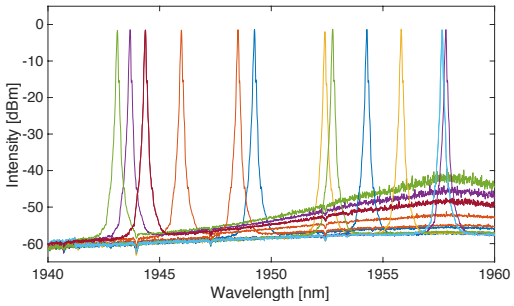


*Figure 1 Typical optical spectra corresponding to wavelength sweeping*

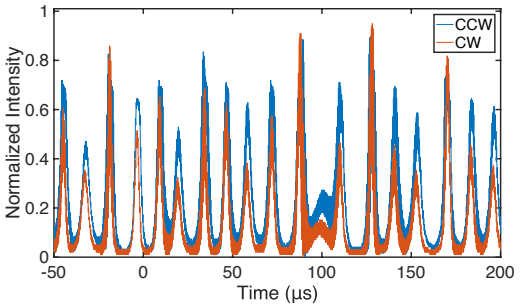


*Figure 2 Pulse burst envelope when the laser wavelength is sweeping*

Reference:

[1] Spreeuw, R. J. C., et al. "Mode coupling in a He-Ne ring laser with backscattering." Physical Review A 42.7 (1990): 4315.

[2] A. E. Siegman, Lasers (University Science Books, Mill Valley, CA, 1986).