Sweeping Range Management in Yb-doped Self-Sweeping Fiber Laser

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The self-induced laser frequency sweeping ("self-sweeping" for short) effect in fiber lasers was discovered several years ago [1–3]. The effect consists in increase (or decrease) of the lasing wavelength in time gradually and jump back to starting wavelength. The key mechanism of the effect is influence of dynamically recorded gain and phase gratings on competition between the laser modes during generation of pulses [4]. One of the key characteristics of self-sweeping lasers is sweeping span (the difference between stop and start wavelengths). The span of self-sweeping lasers can reach 20 nm [4]. Thanks to broad sweeping span and simplicity, self-sweeping fiber lasers are attractive sources for applications demanding tunable radiation. However, there are only a few works [5] are dedicated to investigation of sweeping range in self-sweeping laser. It was experimentally demonstrated that the sweeping span depends on the temperature and wavelength of the pump laser diode.

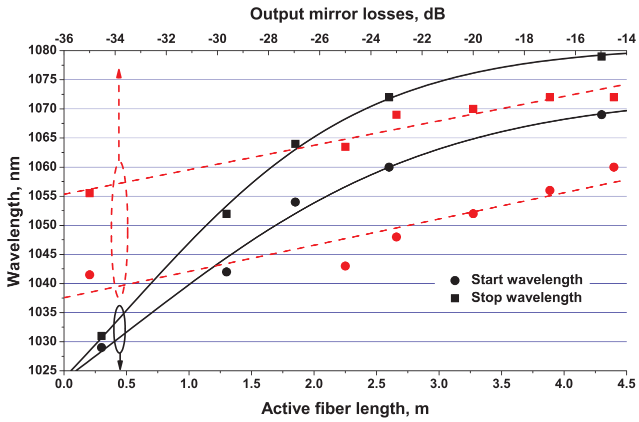

Figure 1: The dependence of the sweeping range on the active fiber length at fixed output mirror losses of -15 dB and on output mirror losses at fixed fiber length of 2.6 m

Here we report on complex research of influence of different factors (active fiber length and temperature, intracavity loss/gain level and laser diode temperature) on sweeping range in ytterbium doped fiber laser. Active fiber length variation allowed us to construct a set of lasers with self-sweeping in a range from 1028 to 1080 nm (figure 1). Simultaneous variation of intracavity loss and pump power level allowed us to tune the self-sweeping range for a laser with fixed active fiber length within 30 nm. At the same time, there are optimal cavity parameters at which sweeping span is the broadest (>20 nm). The span is associated with flattening of the gain profile in Yb-doped fiber. Pump laser diode or Yb-doped fiber temperature management is also an efficient technique for sweeping range control. For example, heating of the fiber by 40 °C results in linear shift of sweeping range by 8 nm to longer wavelengths. Described sweeping range variation can be associated with spectral shape changes of integral gain in the fiber laser. Results of calculations based on gain profile are in a good agreement with experimental data. Thus, described gain control techniques in combination with management of spectrally dependent losses inside the fiber laser cavity represent a set of tools for efficient self-sweeping range control.

References

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