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Narrow bandwidth emitting laser diodes – resonant waveguide grating provides cost-effective wavelength stabilization

Background

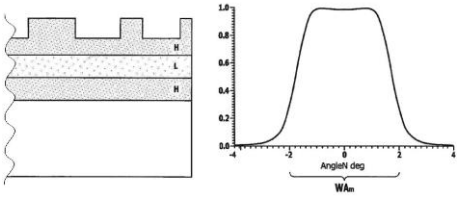
Due to their high conversion efficiency, compact design and comparatively low price, semiconductor diode lasers are highly popular in many technically demanding production areas (welding thin sheets, partial hardening, etc.) and as a pumping source for solid-state lasers. Efficiency of lasers can be increased by pumping the laser active medium at its narrow bandwidth, also called 'zero-phonon line'. This is typically done by externally stabilizing the central wavelength using volume Bragg gratings (VBG).

Problem

Conventional diffraction gratings and volume Bragg gratings are mostly temperature sensitive and can be expensive. For instance, the materials required for volume Bragg gratings are quite expensive.

Solution

The inventors suggest using a resonant multi-layer waveguide grating with a dual-duty-cycle ratio as feedback element to significantly reduce the emission bandwidth of the center wavelength of the diode. This way, a spectral bandwidth of the laser diode down to or even below 0.1 nm can be achieved.
An angle acceptance range of up to 4°, extending the known range by an order of magnitude, is brought about by the multiple duty-cycle of the grating structure, as depicted in the figure. This means that even diodes emitting in a wide-angle range can be stabilized without additional optical components.



Cross section of an exemplary dual-duty-cycle grating with alternating layers with high (H) and low (L) refractive index (left), resulting in high angular acceptance of 4° (right) [IFSW, University of Stuttgart].

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US 8,687,667 B2 granted
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Service
Technologie-Lizenz-Büro GmbH manages inventions until they are marketable and offers companies opportunities for license and collaboration agreements.

Advantages

- highly wavelength selective
- very narrow bandwidth of the emitted beam
  - spectral bandwidths below 0.1 nm possible
- broad angular acceptance (several degrees)
- low production cost (batch production)
- compact design

Application

This wavelength stabilizer, which can be realized in a particularly cost-effective manner, could replace conventional methods such as VBG. The new system uses resonant waveguide gratings (RWG) and is not only very inexpensive to manufacture, but also extremely compact. It has a narrow spectral response and a broad angular acceptance and is particularly suitable for increasing the efficiency of semiconductor diode lasers.