Quantum Dot Broadband Materials for Telecommunication Applications

Sylvain Raymond

Institute for Microstructural Sciences, National Research Council of Canada, Ottawa, Canada

Quantum Dot lasers have properties that are highly influenced by the large inhomogeneous broadening inherent to self-assembled layers. On the one hand this imposes a (low) limit on the peak gain of the device, potentially limiting their efficiency, on the other hand it provides a broad band gain profile which opens the door to exciting applications, for example multi-wavelength lasers and mode-locked lasers.

In this talk I will review the current state of the quantum dot laser project at IMS, focusing on the InAs/InGaAsP/InP material system emitting in the telecom range. A first key finding from experiments is that the anticipated penalties due to low peak gain are largely offset by the benefits of working with a zero-dimensional system, providing lasers with performance either comparable or better than current commercial devices. Using 'trimming' techniques developed at IMS, one can also tune the center of the 'action band' of the devices from the S-band all the way up to the U band (1475 - 1635 nm).

While the limitations of low peak gain have been mitigated, the benefits of the broad band gain are very promising for an array of potential applications. In a first embodiment, one can use a monolithic laser device to obtain a multi-wavelength laser with adjustable channel spacing compatible with the ITU grid. Up to 96 channels all within a 3 dB emission power band can be obtained in this way, with optical signal to noise ratio of 50 dB and relative intensity noise below -115 dB (-136 dB above 2 MHz). In a second embodiment, a monolithic Fabry-Perot laser is used to obtain a mode-locked laser with a high repetition rate (several tens of gigahertz) and ultra short pulse duration down to 312 fs. In certain conditions, these lasers also show a dual wavelength emission which opens the door to intriguing new opportunities.