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Parametric results of the AlGaInAs quantum-well saturable absorber for use as a passive Q-switch

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Abstract: We have successfully designed, built and operated a microlaser based on a AlGaInAs multiple quantum well (MQW) semiconductor saturable absorber (SESA). Optical characterization of the semiconductor absorber, as well as, the microlaser output is presented.

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Compact mircolasers with the capability to produce powerful laser pulses are highly desirable for their ease of use and simplicity of operation. By tailoring the composition of the quaternary compound AlGaInAs a suitable SESA at 1064 nm is obtained. On an InP wafer we grow a stacked sequence of InAlAs spacers at half wavelength intervals between AlGaInAs quantum wells. The transmission lifetime and saturation fluence of the MQW structure is characterized using a pump-probe setup for samples having 20, 40 and 60 quantum wells. Saturation energy and transmission lifetimes are found to be in the range of 0.4-0.7 μJ and 100-300 ns respectively. Figure 1(a) shows the measured increase in transmission of a 40 QW sample as a function of excitation energy from a pump pulse together with a theoretical fit. A modulation in transmission of ≈8% is shown. Figure 1(b) depicts the time resolved transmission after impulse excitation. Single exponential behavior is observed with a lifetime of 296 ns.

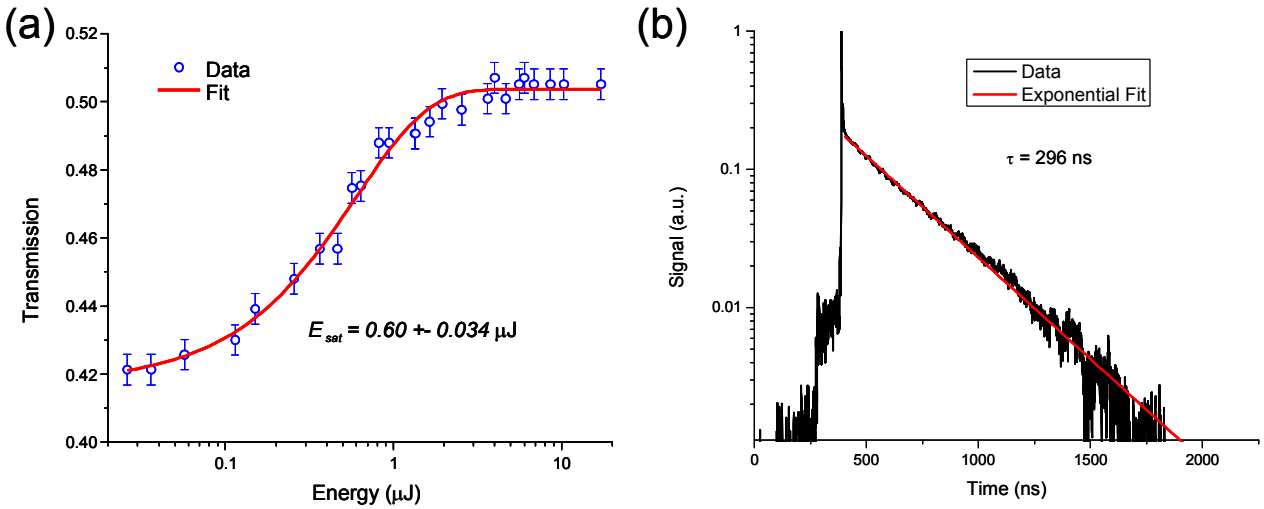

Figure 1. (a) Energy dependent transmission (blue dots) for a sample containing 40 QWs. Exponential fit (red line) depicts a 600 nJ saturation energy (76 μJ/cm^2 saturation fluence). (b) Transmission lifetime (black line) and exponential fit (red line) for a 60 QW sample.

Transmission lifetimes and saturation energies are found to be favorable and support Q-switch operation in the microlaser cavity illustrated in Fig. 2. A commercially available fiber coupled 808 nm diode laser is used to pump the gain medium, 1.0 at. % Nd:YVO_4. Pump light emitted from the 100 μm core fiber is imaged onto the gain which is AR-coated at 808 nm and HR-coated at 1064 nm on one surface and AR-coated at 1064 nm on the second surface. The AR-coated MQW SESA is located

approximately in the middle of the cavity to allow lasing modes to have their field node location align with the QW [1]. Lasing has been achieved with output coupler reflectivity's between 61% and 98%. The entire cavity is 8 mm long and contains only three optical elements. Our SESA microlasers feature high efficiency (25%), single mode operation, excellent beam quality and repetition rates exceeding 1 MHz.

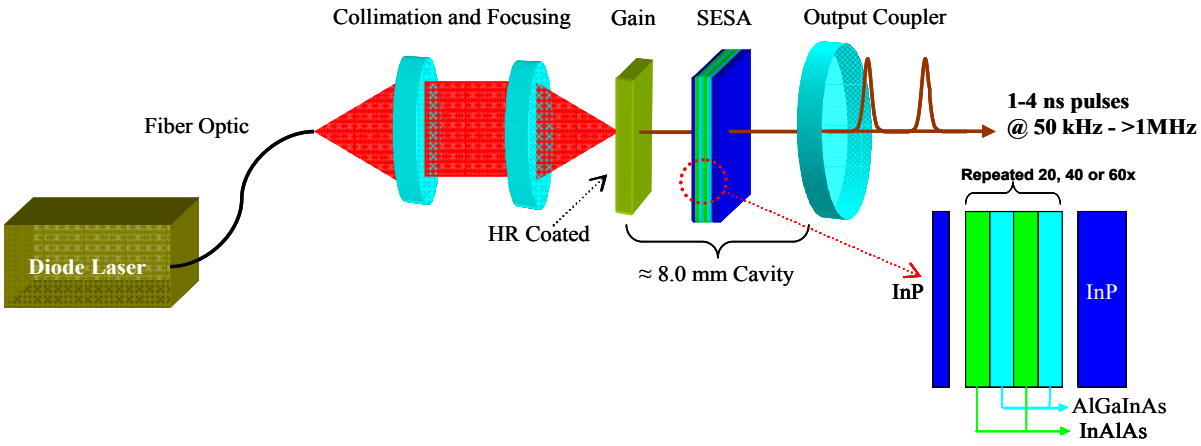

Figure 2. Complete SESA based microlaser system with only three cavity elements. Expanded view of SESA shows QW structure.

References:

[1] S. C. Huang, S. C. Liu, A. Li, K. W. Su, Y. F. Chen, and K. F. Huang, *Opt. Lett.*, **32**, 1480-1482 (2007).