Generation and Detection of Strain Pulses with Passively Mode Locked Semiconductor Laser Diode.

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Generation and detection of ultrasonic waves with ultrashort pulses in gigahertz regime allows one to characterize materials with nanometer spatial resolution. Method is particularly very promising in characterizing mechanical and optical properties of semiconductor nanostructures or biological tissues. Currently, such experimental setups are equipped with sophisticated laser systems. In the frame of NAMIL project (Nano Acousto-Mechanics with Integrated Laser) we move towards a cheaper solution and significant miniaturization providing attractive variation of the technique by implementing a semiconductor mode locked laser diode (MLLD) as a source of light.

Initial part of the project was focused on generation and detection of the strain pulses in thin metal films (Al,Pt,Cr,Au) deposited on GaAs substrates by MLLD based on AlGaInAs/InP quantum-well active media. This laser emits 1-ps duration laser pulses with repetition rate of 20 GHz and average power of 50mW at 830nm wavelength. The MLLD beam was split into two beams. The pump beam modulated by a mechanical chopper was focused by 15x magnification reflective microscope objective to 5-µm spot on the film surface with excitation density of ≈3,8 µJ/cm^2. The probe beam periodically delayed by a shaker with scanning range of 50ps is focused to the same spot with 10 times less density. The modulation of the reflected probe intensity as a function of the shaker position was monitored by a silicon diode locked with a chopper. The detected signal reflects an ultra-short strain pulse generated in a film and its echo arriving back to the surface. The observed signals are in perfect agreement with the data obtained by means of conventional pump-probe setup.

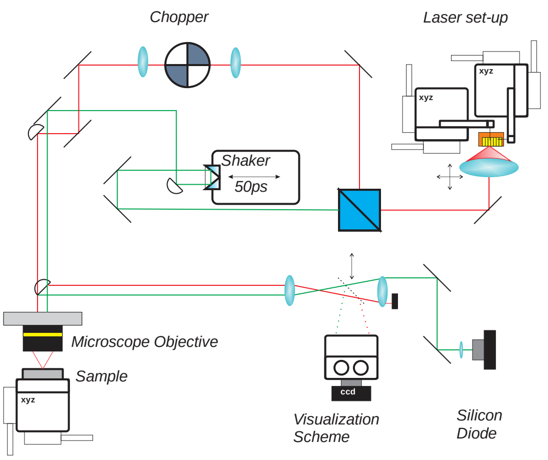

Fig. 1. Experimental set-up

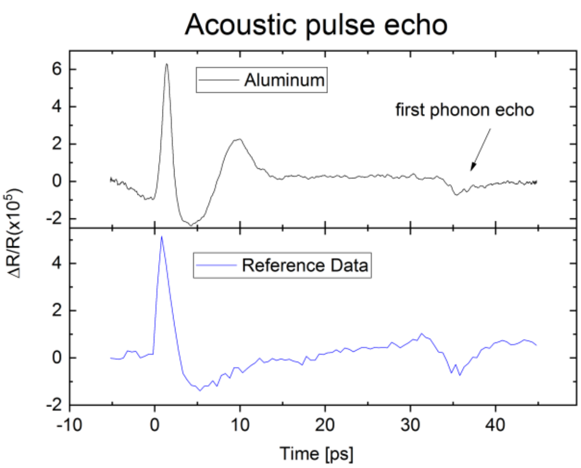

Fig.2. Acoustic echo signal in 100nm Aluminum thin film