Development of a High Speed Laser Flash Method Using a Sub-Nanosecond Thermoreflectance Technique

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A high speed laser flash method has been developed in the National Metrology Institute of Japan (NMIJ, AIST), in order to provide a standard for the heat diffusion time calibration ranging from 10 ns to 1 μs. This heat diffusion time range is available for thermal diffusivity measurements of thin films a sub-micrometer to a few micrometers thick. The measurement system is based upon a rear heating/front detection type thermoreflectance method [1 - 4] as follows: The rear surface of the film is heated by a laser pulse through a transparent substrate. After pulse heating, the heat diffuses one-dimensionally across the film towards the open surface. The temperature change at the front surface can be measured by another probe laser, using a thermoreflectance technique.

In this system, two sub-nanosecond pulse diode lasers are used as the pump and probe pulse sources. Since the pulse repetition of both lasers is 250 kHz, we can observe the heat diffusion of the thin film up to 4 μs. The thermoreflectance signal is measured at a variable delay time of the probe pulse to the pump pulse. The temperature history can be reconstructed with a series of observations when the delay time is systematically changed from 0 to the pulse repetition period [5]. In order to investigate the validity of this system, a thermal diffusivity measurement has been carried out for a TiN thin film 200 nm thick deposited on a glass substrate.

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