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A Kilohertz Femtosecond Ti:Sapphire Regenerative Amplifier

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13. ABSTRACT *(Maximum 200 words)*

To have capabilities in the near-infrared, we proposed to develop a Ti:S regenerative amplifier operating at one kilohertz. This amplifier was developed to amplify the pulses from our femtosecond Ti:S laser oscillator to the 2-3 μJ/pulse energy level. This type of energy in a femtosecond pulse allowed us to generate a broadband ($\simeq 1000$ Å) in the near-infrared for spectroscopic studies of III-V-based semiconductors.

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Summary of the Results

We proposed to build a kilohertz femtosecond titanium-doped sapphire (Ti:S) regenerative amplifier system. The recent development of femtosecond laser pulses from a Ti:S laser oscillator provided us with a new stable source for femtosecond spectroscopy of near-infrared semiconductors. While visible laser dyes have provided good results for femtosecond laser systems and broadband continuum generation, infrared pulse generation from laser dyes has proven less reliable, with a limited tuning range. We built a system capable of producing modest energy pulses (2-3 μJ) at a kilohertz repetition rate for higher average power and better signal-to-noise statistics. We incorporated the latest developments in all solid-state pumped lasers to produce an efficient compact system with improved stability, reliability and longevity. This amplified energy was sufficient to generate a broadband source ($\simeq$1000 Å) of femtosecond duration, which is necessary for studying the absorption features of III-V semiconductor structures. We performed pulse propagation studies in MQW waveguide structures. The tunability of the Ti:S laser system allowed us to study the effects of propagation of femtosecond pulses in waveguides over a broad spectral range. We intend to further study the gain dynamics of a variety of bulk and multiple quantum well semiconductor laser diodes. Since the range of gain spectra varies tremendously with growth composition and structure of the laser diode, it is necessary to have a wavelength flexible femtosecond source to continue these studies.

The amplifier accepted seed pulses from our Ti:S oscillator. For proper operation of the system, the seed pulse was temporally stretched; this form of chirped pulse amplification was needed to keep the instantaneous intensity circulating in the amplifier from causing undesired gain saturation, other nonlinear effects, or even catastrophic damage. After amplification, the pulses were compressed to their original pulse duration. A layout of the amplifier and how it interfaces with our laser oscillator is shown in Fig. 1.

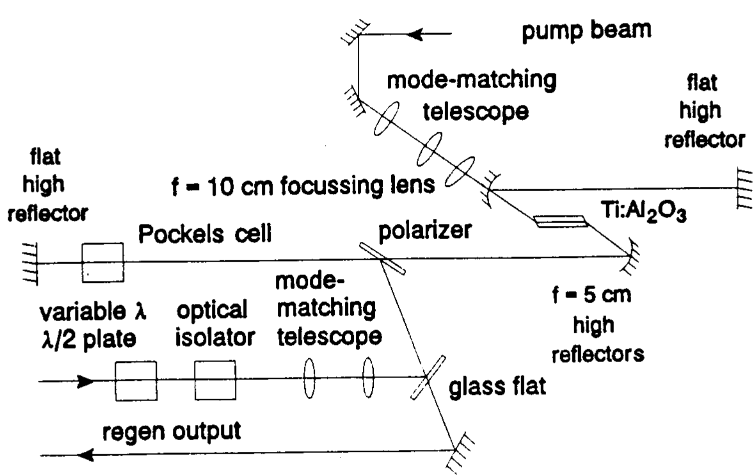

Figure 1. Schematic of Ti:S regenerative amplifier.