INVESTIGATION ON WAVELENGTH, STRAIN, AND BARRIER MATERIALS IN SWIR GASB-BASED SESAMS

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SESAMs (Semiconductor Saturable Absorber Mirrors) are crucial components in ultrafast laser systems. While fast GaAs-based SESAMs are effective in the near-infrared, transitioning to the short-wave infrared (SWIR) is vital for various sensing and spectroscopic applications. This study focuses on growing SWIR SESAMs in the GaSb-based material system, which exhibits distinct material properties.

Standard 2-µm SESAMs with compressively strained InGaSb quantum wells and GaSb barriers demonstrate low saturation fluence F_{sat} and fast recovery time (<30 ps). However, increased two-photon absorption leads to a roll-over of the nonlinear reflectivity curve at lower fluence, as quantified by the F_2 parameter. Attempts to mitigate this issue by using AlAsSb barriers resulted in a desired increase in the F_2/F_{sat} ratio but at the expense of a significant recovery time increase (>500 ps), making the SESAM impractical. Hence, a detailed investigation into barrier materials and strain effects on SESAM performance was conducted.

Introducing higher wavelengths to increase lattice mismatch and strain of the InGaSb quantum wells led to the growth of two SESAMs at 2.3 µm, embedded in GaSb or AlAsSb. Both SESAMs exhibited short recovery times (<10 ps), attributed to a high presence of strain-induced dislocation defects. Additionally, strain-free InGaAsSb QW SESAMs at 2 µm and 2.3 µm displayed slow recovery times regardless of barrier material, underscoring the role of strain-induced defects in controlling GaSb-based SESAM recovery times. Future investigations will explore partially strained InGaAsSb QW SESAMs and qualitatively analyze defect states within the system.