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Employing Time-Resolved Terahertz Spectroscopy to Analyze Carrier Dynamics in $Cu_2ZnSn(S,Se)_4$ Absorber Layers[1] JASON BAXTER, GLENN GUGLIETTA, SIMING LI, Drexel University, KAUSHIK ROY CHOUDHURY, JONATHAN CASPAR, DuPont Central Research and Development, DOUGLAS BISHOP, MICHAEL LLOYD, BRIAN MCCANDLESS, University of Delaware — We report the application of time-resolved terahertz spectroscopy (TRTS) to measure photoexcited carrier lifetimes and mobility, and to determine recombination mechanisms in $Cu_2ZnSn(S,Se)_4$ (CZTSSe) thin films and single crystals. Ultrafast time resolution permits tracking the evolution of carrier density to determine recombination rates and mechanisms. The carrier generation profile was manipulated by varying the photoexcitation wavelength and fluence to distinguish between surface, Shockley-Read-Hall (SRH), radiative, and Auger recombination mechanisms and determine rate constants. Surface and SRH recombination are the dominant mechanisms for the air/CZTSSe/SiO_2/Si film stack. Diffusion to, and then recombination at, the air-CZTSSe interface occurred on the order of 100 picoseconds, while SRH recombination lifetimes were 1 - 2 nanoseconds. Analogous measurements on single crystals reveal the effects of eliminating grain boundaries, reducing point defects and secondary phases, and applying surface treatments to reduce surface recombination velocity. TRTS measurements can provide information that is complementary to conventional time-resolved photoluminescence measurements and can direct the design of efficient thin film photovoltaics. Ref: Guglietta et al., APL, 2014.

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