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Quantifying transient dynamics in materials using time resolved *in situ* TEM

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The dynamic transmission electron microscope (DTEM) is a standard TEM that has been modified such that the electron beam can be operated with a single intense pulse of electrons ($> 10^9$ e^-) with a pulse duration of just 15 ns. The short pulse of electrons is created via photoemission at the microscope cathode and enables time resolved observations of *in situ* experiments. However, it can also be operated in thermionic emission mode for normal operation of the microscope for alignment and experiment setup. Additional modifications have also been made to the optical design of the condenser lens system. The *in situ* experiments currently use a second laser to initiate the dynamic response of interest in the specimen. The relative timing of the pulses from the two laser systems sets the time of the observation relative to the initiation of the event under study. The DTEM has been used to investigate a number of rapid phenomena in materials We have studied the rapid nucleation and growth at the nanoscale of crystalline phases from an initially amorphous metal alloy parent phase and in amorphous Ge. DTEM has also been used to study reactive multilayer films of Ni and Al that sustain a reaction front speed greater than 10 m/s. We have also investigated rapid solidification of nanoscale films of liquid Al-Cu alloys. This work performed under the auspices of the U.S. Department of Energy, Office of Basic Energy Sciences, Division of Materials Sciences and Engineering by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.