Femtosecond Electron Diffraction: Making the "Molecular Movie"

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The ability to watch atoms move in real time – to directly observe transition states – has been referred to as "making the molecular movie". Femtosecond Electron Diffraction (FED) is ideally suited for this purpose, since it records the atomic structure of the sample with sub-Ångstrom spatial resolution and femtosecond temporal resolution. In these experiments, a short electron pulse is diffracted by a thin film sample and the diffraction pattern is recorded at femtosecond intervals after the initiation of the transition in question.

To date, we have obtained atomic level views of thin films of Aluminum[1], Gold and Nickel undergoing a strongly driven melting transition. The results are a fourier-space representations of the changing atomic structure as the atoms move from an ordered crystal lattice to the disordered liquid state. This technique is extremely versatile. It can be used to study many different transitions – including both reversible, and irreversible molecular reactions.

Reaction mechanisms have thus far been a convenient *gedanken* experiment – FED is a promising technique to determine reaction pathways for a large number of organic and inorganic reactions, and can potentially be applied to the understanding of biological systems by providing a link between form and function.

[1] B.J. Siwick, J.R. Dwyer, R.E. Jordan and R.J.D. Miller, *Science*, 302, 1382 (2003).