Femtosecond Electron Diffraction: Making the "Molecular Movie"

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Femtosecond electron diffraction (FED) harbours great potential for providing atomic resolution of structural changes as they occur. This ability to watch atoms move in real time—to directly observe transition states—has been referred to as making the molecular movie. Many-body simulations of ultrashort electron pulse propagation [1] enabled the recent development of sources for femtosecond electron pulses with sufficient number density to execute near single shot structure determinations. This is a necessary requirement to allow studies of irreversible processes. With the realisation of joint femtosecond temporal resolution and sub-Angstrom structural resolution, an atomic level view of melting of a thin film of Al under strongly driven conditions [2] has been obtained in which the process can be desribed as a thermally driven phase transition that takes place in ~3.5 picoseconds. Subsequent studies of the slower melting of Au have further elucidated the mechanism for melt zone propagation.

Ongoing development in electron gun design has further improved the temporal resolution of FED for the observation of transition states in molecular systems. The camera for "making the molecular movie" is in hand.

[1] Siwick B.J., Dwyer J.R., Jordan R.E., Miller R.J.D., *J. Appl. Phys*., 2002, **92**, 1643. [2] Siwick B.J., Dwyer J.R., Jordan R.E., Miller R.J.D., *Science*, 2003, **302**, 1382.

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