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Ultrafast Electron Scattering for Materials Research

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In this talk I will describe how combining ultrafast lasers and electron microscopes in novel ways makes it possible to directly 'watch' the time-evolving structure of condensed matter on the fastest timescales open to atomic motion. By combining such measurements with complementary (and more conventional) spectroscopic probes one can develop structure-property relationships for materials under even very far from equilibrium conditions and explore how light can be used to control the properties of materials.

I will give several examples of the remarkable new kinds of information that can be gleaned from such studies and describe how these opportunities emerge from the unique capabilities of the current generation of ultrafast electron microscopy instruments. For example, in diffraction mode it is possible to identify and separate lattice structural changes from valence charge density redistribution in materials on the ultrafast timescale and to identify novel photoinduced phases that have no equilibrium analogs. It is also possible to directly probe the strength of the coupling between electrons and phonons in materials across the entire Brillouin zone and to probe nonequilibrium phonon dynamics (or relaxation) in exquisite detail.

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