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**Frontiers in Electron Microscopy: Probing the Nanoscale in Nanoseconds**

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Electron microscopy has traditionally been driven by the desire to investigate the result of a given materials process (e.g. nucleation and growth, fatigue etc) at the highest spatial resolution. However, this type of observation typically gives no indication as to how the material achieved its final state. With the nanotechnology revolution highlighting the novel properties that can be achieved by modifying the processing and ambient conditions a material is subjected to, the need to characterize the fundamentals behind the materials process itself has assumed critical importance. One of the developing methods to achieve this level of characterization is dynamic transmission electron microscopy (DTEM). Using a laser pulse to stimulate the electron emission, pulse durations of nanoseconds and shorter can be achieved with sufficient signal to obtain images and diffraction patterns from materials excited by a laser in a pump-probe configuration (with the probe being the electron beam). A novel nanosecond electron microscope incorporating this principle has been used initially to observe the hexagonal close packed (HCP) to body centered cubic (BCC) martensitic phase transformation in titanium. The general class of martensitic phase transformations occur by a rapid shear of the crystal lattice. No long range diffusion is required during these transformations, thus they propagate through a crystal with a speed that can approach the speed of sound. The images and diffraction patterns obtained can be interpreted in terms of the unusual vibrational stabilization of the high temperature BCC phase of Ti. An interesting observation is that the speed of the transition seems to be dependent on the history of the sample and appears to be linked to the presence of oxygen impurities.

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