# Realizing High Performance TEM Cameras for the 21st Century

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The adoption of digital cameras for TEM imaging as a replacement for film has followed a long trajectory over the last 25 years. There have been many fits and starts in both upgrading sensor performance (i.e., tradeoff of CCD vs. CMOS technologies) and system integration limitations (including operating system (O/S) architecture, data transfer protocols, and data storage efficiency).

We have now passed an inflection point in resolving the core issues that have limited performance of TEM digital imaging systems on a cost/performance basis. The gains are fully integrated into the architecture of next-generation TEM cameras. Much as consumer information technologies have scaled rapidly (digital SLR camera pixels, high bandwidth networking), microscopists can now leverage these core technologies to drive TEM imaging performance to previously unattainable levels of resolution, frame rate, and “video” outputs for *in-situ* reactions.

The introduction of the K2 and K2 IS direct detection cameras and the recently announced OneView (fiber optic based CMOS) camera from Gatan, demonstrates this leverage for the highest performance TEM imaging. They function across a broad range of applications including low-dose / beam sensitive materials, sub-millisecond *in-situ* reactions, and 4D-STEM data collection in a single platform.

**Motion of a Step in a Singular High-Angle Tilt Grain Boundary in Gold (Au) at 217 °C**

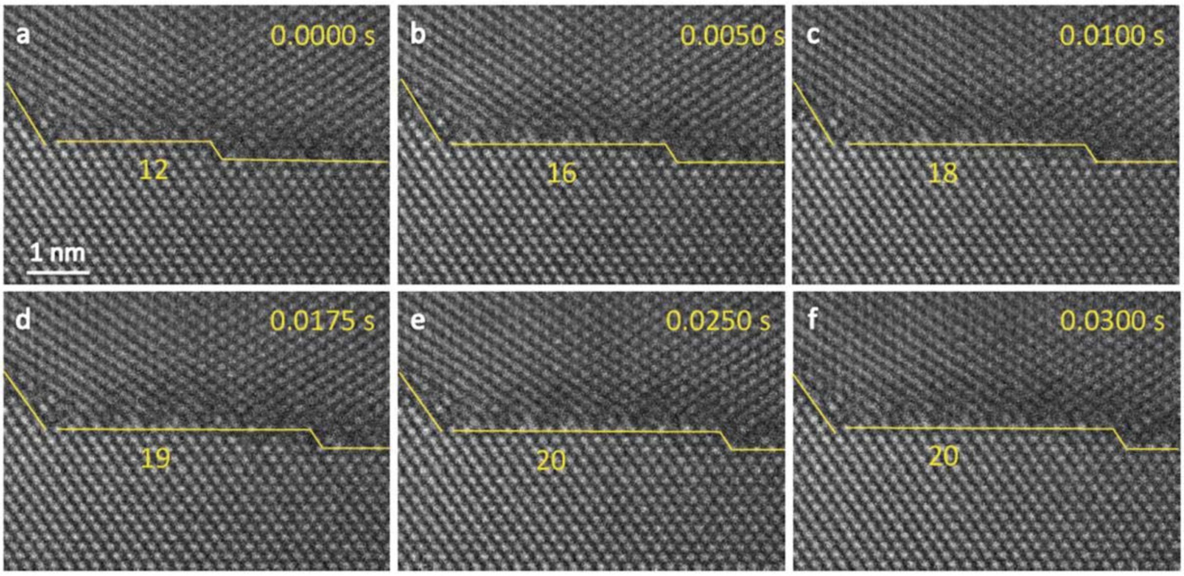


Figure 1. Sequence of images showing propagation of a step (2 atomic planes high) recorded with K2 IS camera at 217 °C. Step position marked as the number of plane spacings from 12 to 20. The whole sequence (a-f) corresponds to a single frame at regular TV rate. Over a more extended time frame this step moves back and forth randomly. Data courtesy of National Center for Electron Microscopy, LBNL, Berkeley California.