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Electron Microscopy: an Analytical Tool for Solid State Physicists

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For too long the electron microscope has been considered as "a big magnifying glass." Modern electron microscopy however has evolved into an analytical technique, able to provide *quantitative* data on structure, composition, chemical bonding and magnetic properties. Using lens corrected instruments it is now possible to determine atom shifts at interfaces with a precision of a few picometer; chemical diffusion at these interfaces can be imaged down to atomic scale. The chemical nature of the surface atoms can be visualized and even the bonding state of the elements (e.g. Mn^{2+} versus Mn^{3+}) can be detected on an atomic scale. Electron microscopy is by principle a projection technique, but the final dream is to obtain atomic info of materials in three dimensions. We will show that this is no longer a dream, but that it is possible using advanced microscopy. We will show evidence of determining the valence change Ce4+ versus Ce^{3+} at the surface of a CeO^2 nanocrystal; the atomic shifts at the interface between $LaAlO^3$ and $SrTiO^3$ and the 3D relaxation of a Au nanocrystal.

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