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NAVIGATING THE NANOWORLD WITH Z-CONTRAST MICROSCOPY

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Navigating the Nanoworld with Z-Contrast Microscopy

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The scanning transmission electron microscope is now capable of forming electron probes of atomic dimensions. Through the technique of Z-contrast microscopy, direct images of nanostructures can be formed at atomic resolution. Furthermore, the probe can be stopped on individual atomic columns selected from the image, and analysis performed by electron energy loss spectroscopy. Our current resolution is 1.3 Å, and information transfer has been demonstrated to 0.78 Å. Recent applications include the double helix arrangement of iodine atoms inside single wall carbon nanotubes with complementary first-principles theoretical calculations that reveal the doping mechanism. The Z-contrast image can be used to determine the surface termination of nanocrystals and also to reconstruct their three-dimensional shape. With a highly dispersed Pt catalyst on gamma-alumina it is possible to image single atoms and small dimers and trimers. Theory can again provide the link from atomic structure to properties. Through correction of lens aberrations, the probe size is predicted to decrease to an unprecedented 0.5 Å, with improvements not only in resolution, but also in image contrast and signal to noise ratio. Single atom sensitivity is anticipated for both imaging and spectroscopy.