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Electron Beam-Driven Chemistry of Nano-Materials

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In important contemporary microscope is the electron microscope. Both the scanning and transmission electron microscopes are important tools for microstructural analysis & microstructural modification. The combination of these two aspects enable structure – property relationships to be studied. Hence it is essential to understand ways with which one can alter or modify materials (and then correlate their properties with their structure). At the extreme of structure modification is the ability to actually create or fabricate a new material, viz., synthesis. In electron microscopes there are numerous ways with which one can modify materials, for example heating or mechanical force. Such methods usually require expensive and specialized equipment in addition to an already expensive electron microscope. A simpler and easier approach is to use the electron beam itself to modify a material. This occurs through various physical processes due to electron beam – sample (material) interactions. Often these are viewed as negative effects if, for example, one wants to collect structural information without altering the material. On the other-hand electron beam interactions and the resultant material changes can be useful. In this presentation the use of the imaging electron beam in transmission electron microscopes for material modification and even materials synthesis is discussed along with an introduction to the different electron-beam specimen interactions. The possibilities are enormous, and for the purposes of this presentation the focus is on low-dimensional materials and how different electron beam interactions with materials can be usefully exploited to modify and grow nano-materials entirely within and electron microscope. The ideas show how the rich electron-beam driven chemistry of materials could eventually be used to form the basis of a nano-laboratory within an electron microscope in which materials can be synthesized and altered in-situ with high degrees of resolution using only the microscopes electron beam.