Implementation of Correlative TEM Information into Atom Probe Reconstruction Routines

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Currently, the most common reconstruction methodologies for atom probe tomography data require knowledge of the material's evaporation field in order to determine the specimen geometry. Unfortunately, this value is not well known for most materials, especially covalent and ionic compounds. With the wide incorporation of laser assisted field evaporation instruments, the temperature dependence of the evaporation field is also needed, as is the specimen temperature during field evaporation. Alternatively, correlative microscopy techniques can be utilized to help confine the evaporated volume as well as many of the other variables required for accurate data reconstruction. However, these variables are still numerous and each contributes to error propagation.

Utilizing correlative characterization techniques during an atom probe experiment introduces the possibility for data reconstruction that does not rely upon knowledge of the evaporation field or specimen temperature, among many other "traditional" reconstruction variables. As detailed recently, in-situ transmission electron microscopy can be used for specimen geometry quantification before and after field evaporation. Such correlative investigations along with electron diffraction allow for atom locations within the evaporated volumes to be quantified a-priori with sub-Å precision. Correlative TEM and diffraction also allows for quantification of the detection efficiency and ion size, further constraining the reconstruction variables. As a result, only the image compression factor is variable and may be quantified in many cases. Examples of this methodology illustrate the possibility of 3-D atomic resolution in APT. Challenges for future implementation exist, especially in terms of mass spectrum analysis and heterointerfaces. However, optimization routines for these reconstructions are shown to simplify the selection of reconstruction variables, again improving the accuracy of the spatial information.