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Atomic resolution transmission electron microscopy of radiation sensitive specimens

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Sub-ångström resolution has been demonstrated in transmission electron microscopy (TEM) and scanning TEM (STEM) imaging experiments thanks to the recent development of spherical and chromatic corrected equipment and/or to the development of methodologies capable to overcome the limitations related to the electron optical aberrations. Moreover, a special attention has to be paid to the eventual damage induced by the electron irradiation that can alter the structure of the specimen. Radiation damage has a dramatic sudden effect on soft matter or biologic specimens but can also affect in a subtle way the study of inorganic specimens, preventing an accurate and reliable quantification of their properties. The use of new TEM/STEM aberration corrected equipment and field emission cathodes enable to deliver a high-density of current on the specimen making radiation damage an issue of growing importance also for inorganic material and even for metals. Radiation damage is the basic handicap to atomic resolution of single particle in biology or to the development of atomic resolution methods for electron tomography. Here is discussed how in-line holography in Transmission Electron Microscopy enables the study of radiation-sensitive nanoparticles of organic and inorganic materials providing high-contrast holograms of single nanoparticles, while illuminating specimens with a density of current as low as 1 e-Å^{-2s} s⁻¹. This provides a powerful method for true single-particle atomic resolution imaging and opens new perspectives for the study of soft matter in biology and materials science(1). The approach is not limited to a particular class of TEM specimens, such as homogenous samples or samples specially designed for a particular TEM experiment but has better application in the study of those specimens with differences in shape, chemical composition, crystallography, and orientation, which cannot be currently addressed at atomic resolution.

1 Elvio Carlino, In-Line Holography in Transmission Electron Microscopy for the Atomic Resolution Imaging of Single Particle of Radiation-Sensitive Matter. Materials 2020, 13, 1413; doi:10.3390/ma13061413

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