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Laser control of transmission electron microscope electron wave function CARTER TURNBAUGH, OSIP SCHWARTZ, JEREMY AXELROD, SARA CAMPBELL, ROBERT GLAESER, HOLGER MLLER, University of California, Berkeley and Lawrence Berkeley National Laboratory — We demonstrate continuous laser control of the spatial phase of an electron wave function in a transmission electron microscope (TEM). Using a near-concentric Fabry-Perot cavity, we produce record continuous-wave laser intensities ($\sim 43\mathrm{GW/cm^2}$) required to manipulate electron wave functions via the ponderomotive potential. We acquire a TEM image of the free-space light wave, showing the effect of the light wave on the electron beam. The periodic structure of the standing light wave also acts as an electron diffraction grating, and we recorded images showing the electron diffraction. Finally, in the back focal plane of the TEM, we aligned the unscattered electron beam of the TEM with a standing light wave antinode in order to phase shift the unscattered beam relative to the scattered beam. These results can be applied to create a Zernike phase plate for TEMs. In electron microscopy of cryogenically frozen biomolecules, specimens produce very little amplitude contrast and only weak phase contrast. Although techniques exist to use the TEM optics to produce some contrast, they provide little low frequency information, which limits the ability to perform atomic resolution 3D reconstructions of smaller proteins.

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