Iterative wave reconstruction with the use of GPU

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Iterative wave function reconstruction (IWFR)

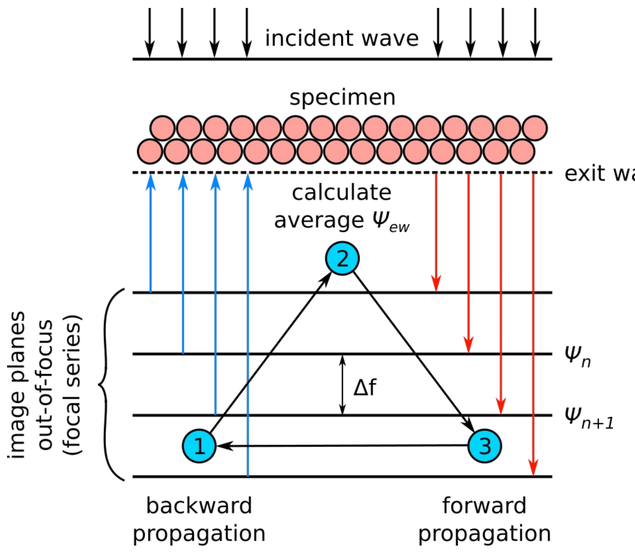
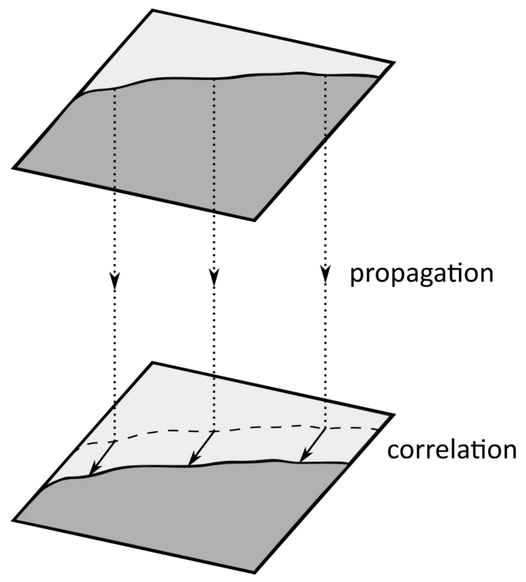


Fig. 1. IWFR algorithm. Each iteration consists of 3 steps: (1) backward propagation of experimental wave functions, (2) calculating average exit wave function at "in-focus" plane, (3) forward propagation to "out-of-focus" planes.

Fig. 2. In order to determine shift between two differently defocused images we "propagate" the first image to the second image plane and then calculate correlation function at the same plane.

Drift correction with propagation



CUDA architecture of GPU

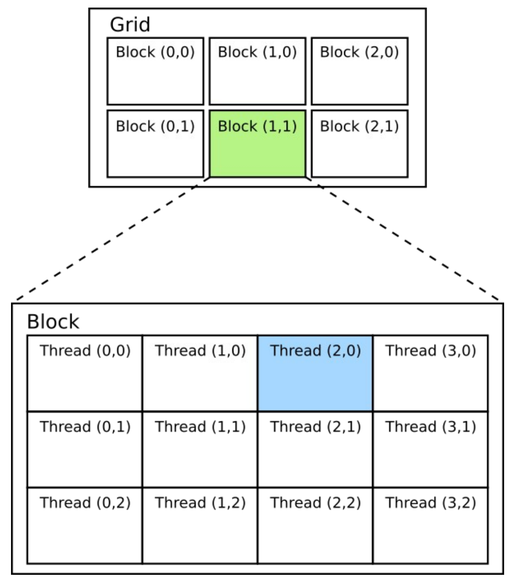


Fig. 3. CUDA architecture: grids consisting of blocks which consist of threads.

Triangulation alignment

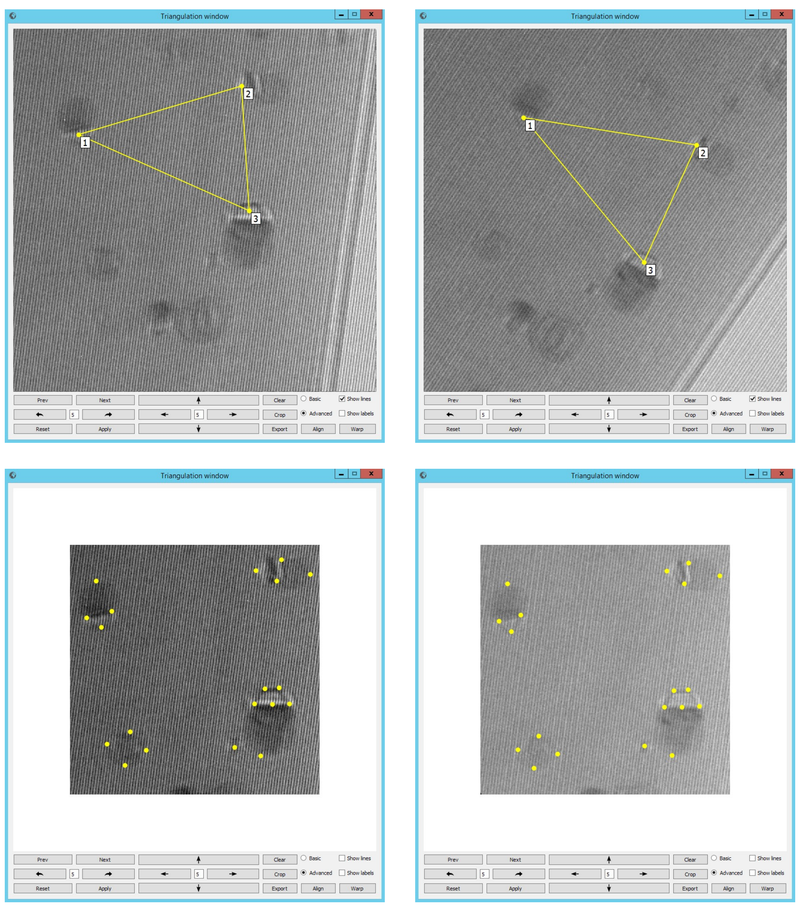


Fig. 4. Due to geometric distortions (shift, rotation, magnification) which appear at large defocus PyTriangulate tool for overlapping images was developed. It can be used to (1) find the center and angle of rotation between two sets of points (first row) and (2) warp images in order to match two sets of points (second row).

Mutual-correlation alignment

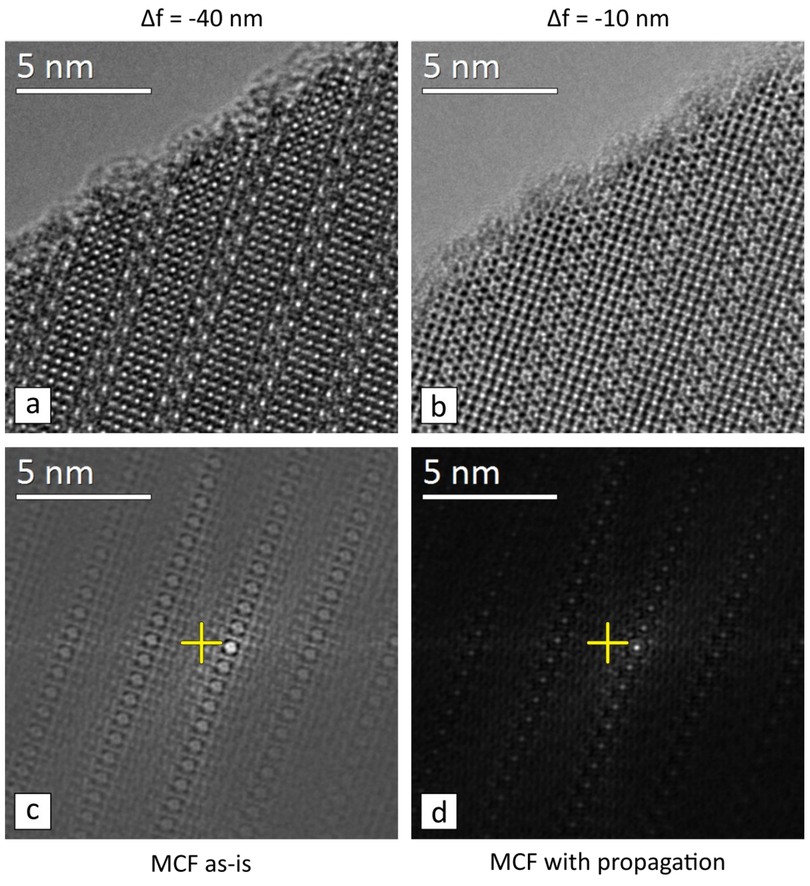


Fig. 5. (a, b) Experimental HRTEM images showing the same area of specimen for different values of defocus. (c) MCF image of two original HRTEM images, (d) MCF image obtained after "propagation" of the first TEM image towards the plane of second TEM image through the distance of $\Delta z \approx 30$ nm. The displacement of MCF peak position with respect to the center of MCF image (indicated by the yellow cross) corresponds to the in-plane shift between TEM images.

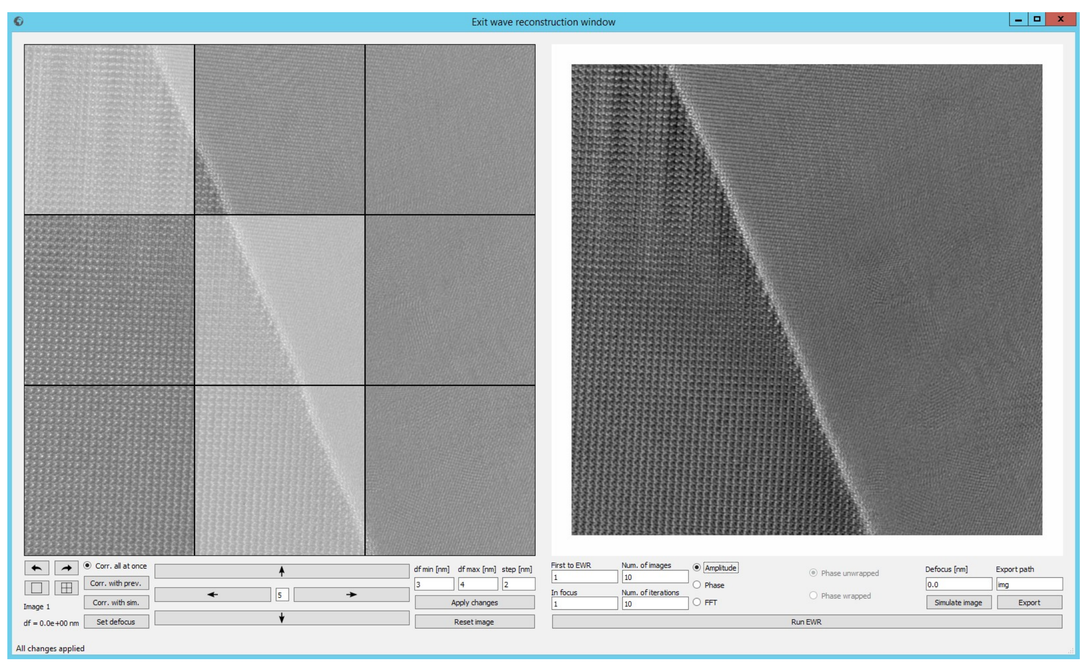


Fig. 6. PyIWFR software (written in Python) for restoring amplitude and phase of exit electron wave from a focal series.

IWFR results

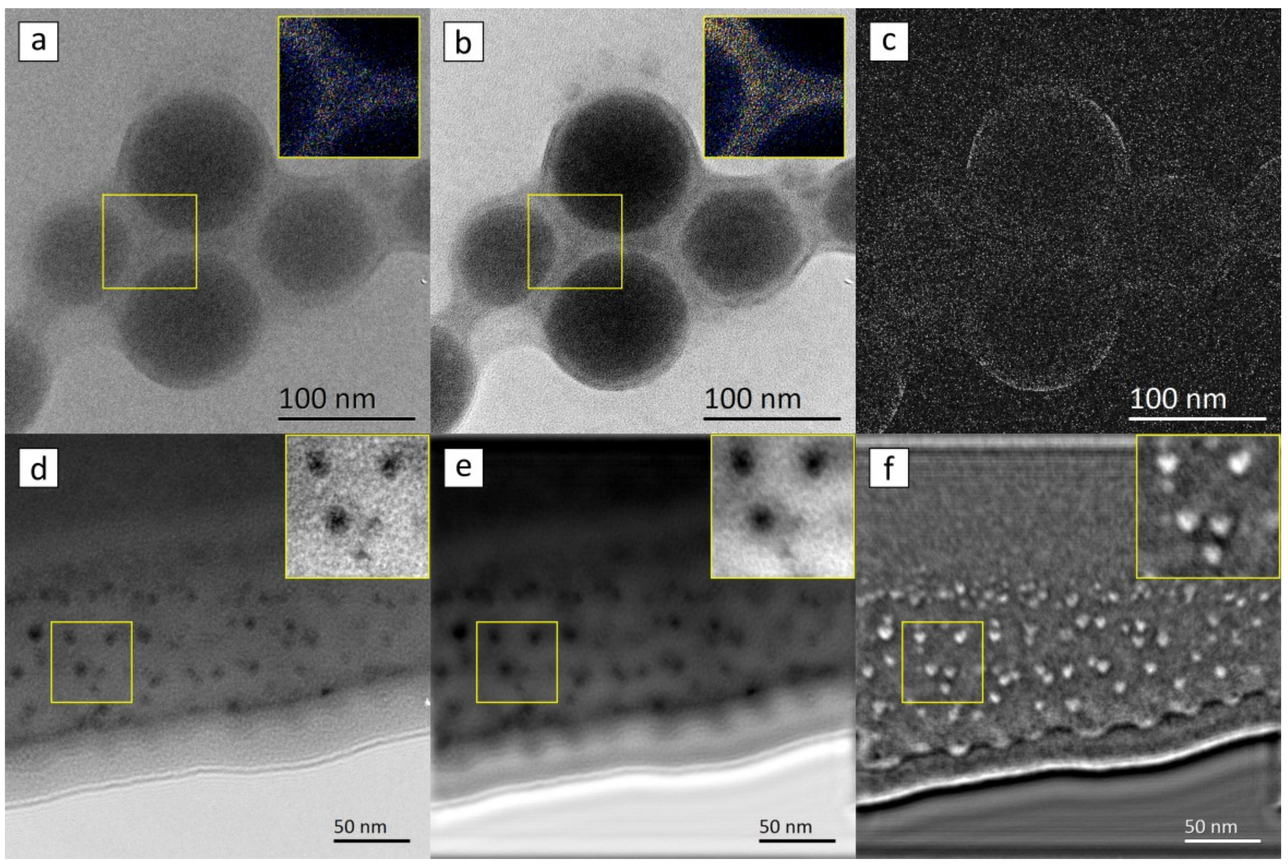


Fig. 7. Experimental TEM images (a,d) and the results of in-line electron holography, including restored amplitude images (b,e) and restored phase images (c,f), for: acrylic-polymer particles with core-shell structure (first row) and Mn-rich nanoprecipitates embedded in (Ga,Mn)As matrix (second row).

References

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Acknowledgements

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