

Description of Additional Supplementary Files:

Supplementary Movie 1. **In situ CDI experiment with a materials science sample.** The magnitude of the complex exit waves reconstructed by in situ CDI, capturing the growth of Pb dendrites on Pt electrodes immersed in an aqueous solution of $\text{Pb}(\text{NO}_3)_2$ as a function of the applied voltage.

Supplementary Movie 2. **In situ CDI experiment with a biological sample.** Phase images of the fusion of glioblastoma cells reconstructed by in situ CDI.