



Correlated Electron-Matter Interactions: From Inelastic Scattering to Beam Focusing via Rotationally Structured Crystals

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We report the cylindrical symmetric rotating crystal (CSRC), a novel anisotropic crystal growth structure that exhibits island morphology in real space and Kikuchi diffraction patterns in momentum space. Simulations reveal that diffracted bright spots converge to a single point independent of incident beam position, suggesting the potential for micron-scale electron lenses using CSRC.

Introduction

Recently, Emanuel M. Avrahami et al. [1] reported that complex morphologies of biogenic crystals emerge from anisotropic growth of symmetry-related facets, demonstrating that the rotating crystal derives from asymmetric growth of symmetrically related crystallographic planes. Here, we present an even more interesting asymmetric crystal growth structure: the cylindrical symmetric rotating crystal (CSRC) [2, 3]. The CSRC simultaneously exhibits island morphology in real space and Kikuchi diffraction patterns in momentum space in the raster scan mode of scanning electron microscopy. This new experimental observation suggests a potential mechanism beyond current diffraction theories.

Figures and Tables

Based on the combination of the Monte Carlo method and machine learning, we performed simulations of electron interactions with the CSRC. The results indicate that the diffracted bright spots can be made to converge at the same point, independent of the electron beam's incident position. This suggests the feasibility of using a CSRC to construct a micron-scale electron lens, which could potentially replace current meter-scale electromagnetic lenses. Such a development would represent a significant step toward miniaturizing electron optical systems, with implications for portable electron microscopy and advanced materials characterization. The CSRC thus presents a promising platform for the design of novel electronic components, and further investigation into its potential applications is warranted.

Conclusion

The cylindrical symmetric rotating crystal (CSRC) presents a novel form of asymmetric crystal growth with distinct electron diffraction behavior. Our simulations show that it can focus diffracted electrons to a single point, independent of the beam's incident position. This property indicates the CSRC's potential to function as a micron-scale electron lens, offering a new pathway for miniaturizing electron optical systems and developing portable, high-performance instruments.

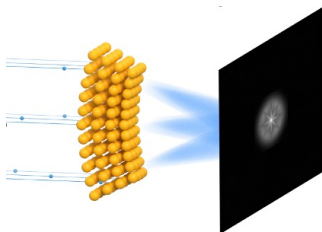


Figure 1. Using a CSRC to focus electron beam.

References

- [1] E. M. Avrahami et al., Science 376, 312 (2022).
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