

Near atomic resolution imaging of an imine-based 2D polymer using aberration-corrected high-resolution electron microscopy

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2D polymer, a rising star in the family of 2D materials, holds great promise in the rational materials design tailored for the next-generation applications [1]. However, unlike its inorganic counterparts, such as graphene and transition metal dichalcogenides, where the pristine and defect structures have been unambiguously demonstrated via aberration-corrected high-resolution transmission electron microscopy (AC-HRTEM). The structural characterization of 2D polymers remains a formidable task. Due to the strong interaction between the incident electrons and organic materials, 2D polymers undergo instantaneous structural degradation in the imaging process (i.e., radiation damage), posing a significant limit on the achievable image resolution [2].

Here, we present a systematic optimization of the TEM imaging conditions, with the aim to enhance the image resolution on 2D polymers. By utilizing low-dose techniques, we characterize the molecular structures in an imine-based 2D polymer synthesized on an air-water interface. With the optimized imaging conditions, we successfully elucidate not only the pristine but also defect structures with a near atomic resolution of 2.3 Å (Fig. 1). Our technique allows for a straightforward identification of nodes and linkers in the molecular network, providing direct structural information on grain boundaries, such as, high-angle/low-angle grain boundary, antiphase boundary, etc. Intriguingly, structural reconstruction at grain boundaries have been identified. The direct observation of detailed grain boundary structures lends significant insights into their formation mechanisms during 2D polymerization.

References

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- [2] S. T. Skowron, T. W. Chamberlain, J. Biskupek, U. Kaiser, E. Besley and A. N. Khlobystov *Acc. Chem. Res.* 50 (2017) 1797.

Figures

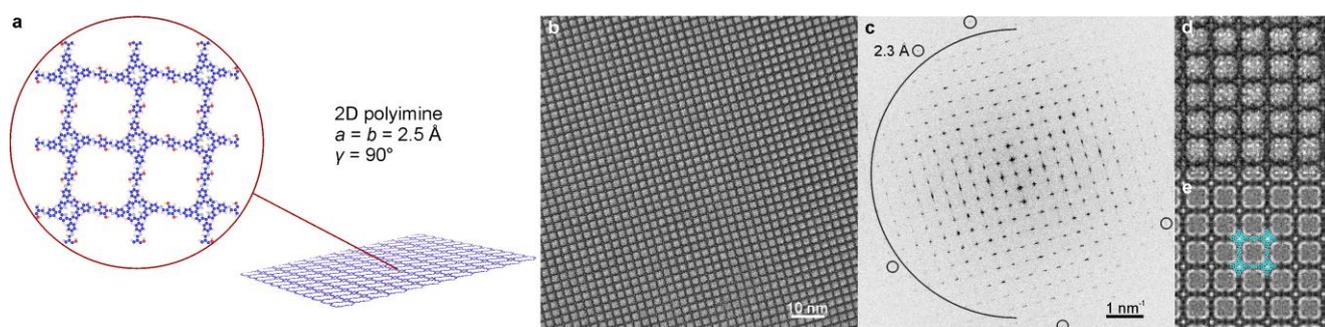


Figure 1: **a**, Schematic of 2D polyimine. **b**, HRTEM image (unprocessed). **c**, Fast-Fourier transform pattern of (b) showing image resolution of 2.3 Å. **d**, Magnified image from (b). **e**, Simulated HRTEM image.