Controllable Graphene Growth on Photonic Crystal Fibre for Nonlinear Enhancement

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Abstract

Hollow-Core Photonic Crystal Fibre (HC-PCF), which guides majority of the light in the hollow core, is often used for high harmonic generation (HHG) by integration with functional gases [1]. Compared with nonlinear crystals, these gases with low density of atoms show low HH intensity, which prohibits its practical application. The emergence of graphene with zero-gap nature provides a feasible alternative. Previous study has observed up to ninth-order harmonics using transferred graphene [2]. But the tedious and complicated transferring process inevitably influences the quality of graphene, while graphene with atomic thickness limits light-matter interaction and thus degrades HH intensity. Therefore, we designed a low-pressure direct chemical vapour deposition (LPCVD) route to synthesize graphene PCF (Gr-PCF) with graphene inside the microscopic holes of PCF (Figure 1). The as-fabricated graphene inside PCF exhibits high crystalline and uniformity with the thickness of 1-2 layers (Figure 2). Moreover, compared with planar surface, Gr-PCF can enable a distinct enhancement of light-matter interaction, which paves the way for its potential advent of novel nonlinear wavelength converters.

References

[1] U. Keller, Applied Physics B, 97 (2009) 369-373
[2] N. Yoshikawa, Science, 356 (2017) 736-738.

Figures

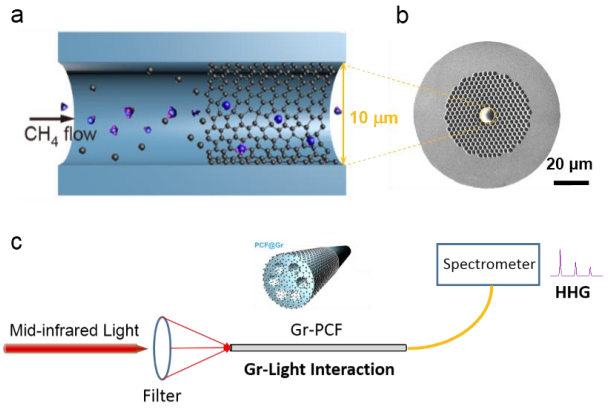

Figure 1: Schematics of Gr-PCF synthesis and its potential applications. a, Schematics of Gr-PCF grown by CVD method. **b**, SEM image of Gr-PCF end surface. **c**, Potential applications of Gr-PCF in HHG.

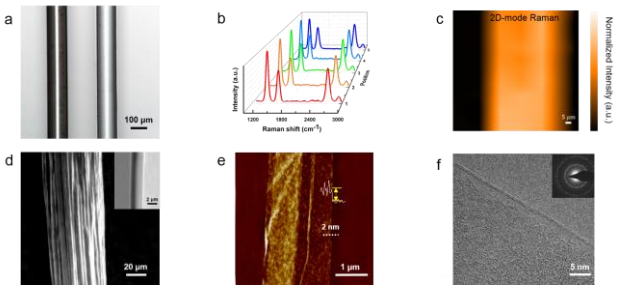

Figure 2: Characterization of Gr-PCF. a. Optical contrast between Gr-PCF (left) and bare PCF (right). **b-c**, Raman spectrum (b) and 2D-mode Raman intensity mapping of as-synthesized graphene fibre after etching the quartz. **d**, SEM image of bundles of graphene ribbons (Inset: single graphene ribbon). **e**, AFM image of a single graphene ribbon. **f**, High-resolution transmission electron microscopy (HRTEM) image of the graphene ribbon (Inset: the corresponding selected-area electron diffraction pattern).