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Authors: Zhongtao Chen, Xinli Guo, Long Zhu, Long Li, Yuanyuan Liu, Li Zhao, Weijie Zhang, Jian Chen, Yao Zhang, Yuhong Zhao



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## Direct growth of graphene on vertically standing glass by a metal-free chemical vapor deposition method

Zhongtao Chen <sup>a</sup>, Xinli Guo <sup>a,\*</sup>, Long Zhu <sup>a</sup>, Long Li <sup>b</sup>, Yuanyuan Liu <sup>a</sup>, Li Zhao <sup>a</sup>,  
Weijie Zhang <sup>a</sup>, Jian Chen <sup>a</sup>, Yao Zhang <sup>a</sup>, Yuhong Zhao <sup>c,\*</sup>

<sup>a</sup> *Jiangsu Key Laboratory of Advanced Metallic Materials, School of Materials Science and Engineering, Southeast University, Nanjing 211189, China*

<sup>b</sup> *Yinbang Clad Material Co., Ltd, Wuxi 214145, China*

<sup>c</sup> *College of Materials Science and Engineering, North University of China, Taiyuan 030051, China*

\*Corresponding authors.

*E-mail addresses:* guo.xinli@seu.edu.cn (Xinli Guo); zhaoyuhong@nuc.edu.cn (Yuhong Zhao)

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A new method to directly grow graphene on quartz glass substrate by atmospheric-pressure chemical vapor deposition (CVD) without using any catalyst was developed. The prime feature of this method is to build a vertical-glass model in the quartz tube to significantly increase the collision probability of the carbon precursors and reactive fragments between each other with the glass surface. The growth rate of high-quality graphene on glass remarkably increases compared with the conventional gas flow CVD technique. The optical transmittance and sheet

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