Controlled growth of single-crystal graphene wafers on twin-boundary-free Cu(111) substrates

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Abstract

Single-crystal graphene wafers have been proven to be compelling candidates for post-silicon semiconductor technology, owing to the excellent carrier mobility, wafer-scale performance uniformity, and fine compatibility with silicon CMOS integration. Controlled synthesis of high-quality and single-crystal graphene wafers has been regarded as the key guarantee to bridge graphene materials close to high-performance electronic and optoelectronic devices. However, current graphene wafers grown by chemical vapor deposition approach still suffer from the presence of twin boundaries on Cu substrate, which would highly degrade the aligned epitaxial growth of graphene domains. Herein, we demonstrated an efficient method to fabricate 4-inch Cu(111) single-crystal wafers without the existence of in-plane twin boundaries. An ingenious temperature gradient was applied during the annealing process to drive the abnormal grain growth from center to the edge of Cu substrates. Graphene wafers grown on twin-boundary-free Cu(111) substrates shows improved crystallinity (the percentage of aligned graphene domains > 97%), which contributes an enhancement in the electrical properties such as carrier mobility and sheet resistance. This work provides a new insight into the fabrication of single-crystal Cu(111) wafers without lattice defect, and exciting opportunities for the utilization of single-crystal graphene wafers for advanced applications.

References

[1] L. Lin, B. Deng, J. Sun, H. Peng, and Z. Liu, Chem. Rev. 118 (2018), 9281-9343
[2] K. Jia, J. Zhang, Y. Zhu, L. Sun, L. Lin, and Z. Liu, Appl. Phys. Rev. 8 (2021), 041306

Figures

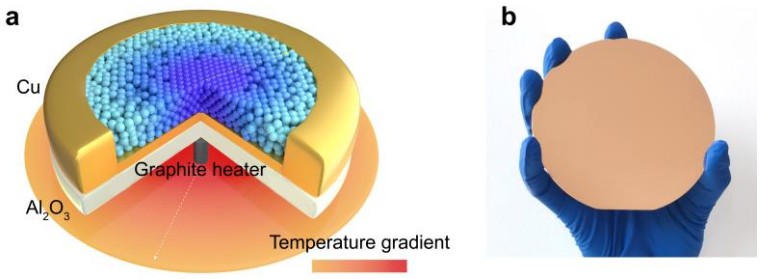

Figure 1: Controlled growth of twin-boundary free single-crystal Cu(111) wafers