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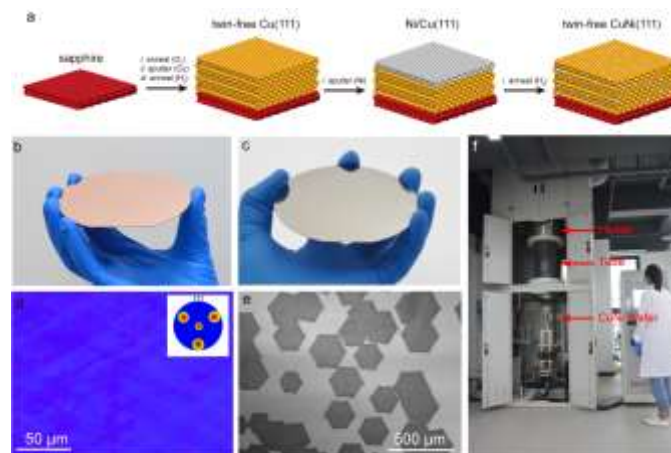
# Graphene as Electronic Materials: Controlled Growth of Single-Crystal Graphene Wafer

Similar to silicon (Si) wafers as the cornerstone of modern Si based electronics, single-crystal graphene wafers are vital components in future high-performance graphene electronics. Two approaches have been employed for single-crystal graphene growth by chemical vapor deposition (CVD), that is, the single-nucleation approach enabled by reducing the nucleation density, and the multi-nucleation approach featured with oriented graphene growth on an epitaxial substrate. Cu(111) is a substrate enabling epitaxial growth of graphene. We fabricated single-crystal Cu(111) thin films free of in-plane twinning on sapphire by magnetron sputtering and solid state recrystallization process. 4 inch single-crystal graphene was grown on the Cu(111) by APCVD.<sup>[1]</sup> The single-crystallinity was confirmed by multiscale characterization, including OM, SEM, Raman, LEED, and TEM. To improve the growth rate, single-crystal Cu<sub>90</sub>Ni<sub>10</sub>(111) thin films were fabricated. 4 inch single-crystal graphene was grown on the CuNi(111) within 10 min, 50 folds faster than that of Cu(111).<sup>[2]</sup> Single-crystal graphene grown on Cu(111) and CuNi(111) can be free of wrinkles, which further improved the electrical and mechanical properties of graphene.<sup>[3]</sup> One of the best benefits of graphene growth on the Metal(111) lies in the compatibility with wafer technology. A pilot-scale APCVD system is designed and built, and we are paving the way toward mass production of single-crystal graphene wafers.

## References

- [1] Bing Deng, Zhongfan Liu, Hailin Peng, et al. *ACS Nano*, **2017**, 11, 12337.
- [2] Bing Deng, Zhongfan Liu, Hailin Peng, et al. *Advanced Materials*, **2018**, submitted.
- [3] Bing Deng, Zhongfan Liu, Hailin Peng, et al. *Small*, **2018**, 14, 1800725.

## Figures



**Figure 1:** (a) Fabrication of single-crystal CuNi(111) thin films. (b) Photograph of a Cu(111) wafer. (c) Photograph of a CuNi(111) wafer. (d) EBSD of Cu(111). (e) SEM image of graphene grown on CuNi(111). (f) A homemade pilot-scale APCVD system for mass production of single-crystal graphene wafer.