2019 年度夏学期 第 4 回 駒場物性セミナー

二次元層状物質の自動劈開・探索・積層による ファンデルワールス超格子の作製

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日時 2019 年 5 月 31 日(金) 午後 4 時 50 分

場所 16 号館 827

Abstract:

Van der Waals heterostructures are comprised of stacked atomically thin two-dimensional crystals and serve as novel materials providing unprecedented properties. However, the random natures in positions and shapes of exfoliated two-dimensional crystals have required the repetitive manual tasks of optical microscopy-based searching and mechanical transferring, thereby severely limiting the complexity of heterostructures.

To solve the problem, we develop a robotic system that automatically searches exfoliated 2D crystals and assembles them into vdW superlattices inside the glovebox [1]. The system can autonomously detect 400 monolayer graphene flakes per hour and stack four cycles of the designated two-dimensional crystals per hour with few minutes of human intervention for each stack cycle. The system enabled fabrication of the vdW superlattice structures consisting of 29 alternating layers of the graphene and the hexagonal boron nitride flakes. Fabricated graphene devices exhibited unprecedented charge carrier mobilities (>1,000,000 cm^2/Vs), demonstrating the suitability of the method for prototyping variety of high quality vdW superlattices. The fabrication efficiency can be further enhanced by developing the machine-learning algorithm for automatically identifying graphene flakes form the optical microscopy images [2], which eliminates the parameter tuning process to detect graphene flakes.

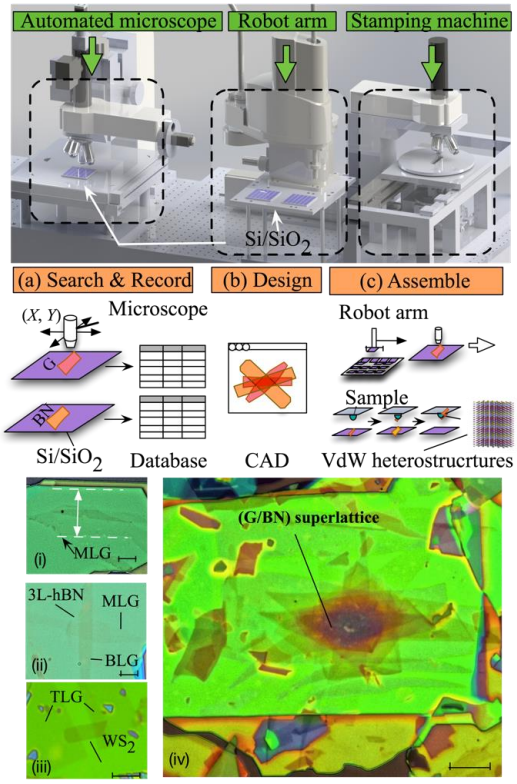

Fig. (top) The schematics of automated assembly system. (middle) Fabrication process. (bottom) vdW heterostructures. Scale bar corresponds to 5 μm.

[1] S. Masubuchi et al., Nature Communications 9, 1413 (2018).

[2] S. Masubuchi et al., npj 2D Materials and Applications 3, 4 (2019).

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