# Selective Growth of van der Waals Heterostructures Enabled by Electron-Beam Irradiation

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Van der Waals heterostructures (vdWHSs) enable the fabrication of complex electronic devices based on two- dimensional (2D) materials. Ideally, these vdWHSs should be fabricated in a scalable and repeatable way and only in the specific areas of the substrate to lower the number of technological operations inducing defects and impurities.

Here, we present a method of selective fabrication of vdWHSs via chemical vapor deposition by electron-beam (EB) irradiation. We distinguish two growth modes: positive (2D materials nucleate on the irradiated regions) on graphene and tungsten disulfide (WS2) substrates, and negative (2D materials do not nucleate on the irradiated regions) on the graphene substrate. The growth mode is controlled by limiting the air exposure of the irradiated substrate and the time between irradiation and growth. We conducted Raman mapping, Kelvin-probe force microscopy, X-ray photoelectron spectroscopy, and density-functional theory modelling studies to investigate the selective growth mechanism.

We conclude that the selective growth is explained by the competition of three effects: EB-induced defects, adsorption of carbon species, and electrostatic interaction. The method here is a critical step toward the industry-scale fabrication of 2D-materials-based devices.

## References

[1] J. Sitek *et al.*, ACS Applied Materials & Interfaces, 15, 28 (2023), 33838-33847

## Figures

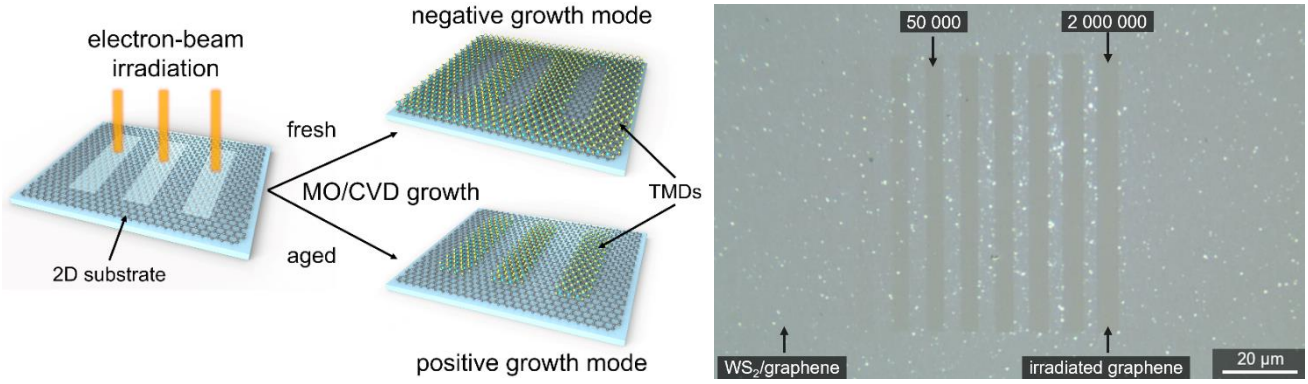


**Figure 1:** (left)Schematic of the electron-beam irradiation selective growth method; (right) Optical micrograph showing lack of $WS_2$ growth on irradiated graphene.