

2.1: Mechanical peeling: Also known as the “duct tape” method. It involves peeling off thin layers of graphene using adhesive tape to obtain single-layer graphene. This method can produce high-quality graphene flakes but is not scalable for large-scale production.

2.2: Liquid-phase exfoliation: This method involves dispersing graphene in a suitable solvent (e.g., water, organic solvent, or ionic liquid) and applying mechanical force (e.g., sonication) to separate graphite layers and produce graphene nano-sheets. This method is relatively simple and scalable, but the graphene produced may have lower quality than other methods.

2.3: Epitaxial growth: This method involves growing graphene on a suitable substrate, such as silicon carbide (SiC) or transition metal surfaces. The substrate serves as a template for graphene growth, which can be controlled and customized to achieve specific properties. Epitaxial growth can produce high-quality graphene with a large surface area but requires specialized equipment and careful monitoring of growth conditions.

2.4: Reduction of graphene oxide: This method involves the oxidation of graphite to produce graphene oxide, which is then chemically or thermally reduced to yield reduced graphene oxide (rGO). This method is relatively simple and scalable, but the graphene produced may have defects and lower quality compared to other methods.

2.5: Chemical vapor deposition (CVD): This method involves the decomposition of hydrocarbon gases (such as methane or ethylene) on a metal surface (usually copper or nickel) at high temperatures. Carbon atoms from decaying gases are deposited on the surface of the metal to form a layer of graphene. CVD can produce large-area, high-quality graphene films, but requires specialized equipment and a controlled environment.

Each graphene production method has its own advantages and limitations in terms of cost, scalability, quality, and specific properties of the graphene produced. The choice of production method often depends on the graphene's intended application and desired properties. Schematic illustration of the main graphene production techniques.