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A critical review of the effects of fluid dynamics on graphene growth in atmospheric pressure chemical vapor deposition (Review)

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Abstract

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Chemical vapor deposition (CVD) of graphene has attracted high interest in the electronics industry due to its potential scalability for large-scale production. However, producing a homogeneous thin-film graphene with minimal defects remains a challenge. Studies of processing parameters, such as gas precursors, flow rates, pressures, temperatures, and substrate types, focus on improving the chemical aspect of the deposition. Despite the many reports on such parameters, studies on fluid dynamic aspects also need to be considered since they are crucial factors in scaling up the system for homogenous deposition. Once the deposition kinetics is thoroughly understood, the next vital step is fluid dynamics optimization to design a large-scale system that could deliver the gas uniformly and ensure maximum deposition rate with the desired property. In this review, the influence of fluid dynamics in graphene CVD process was highlighted. The basics and importance of CVD fluid dynamics was introduced. It is understood that the fluid dynamics of gases can be controlled in two ways: via reactor modification and gas composition. This paper begins first with discussions on horizontal tubular reactor modifications. This is followed by mechanical properties of the reactant gasses especially in terms of dimensionless Reynolds number which provides information on gas flow regime for graphene CVD process at atmospheric pressure. Data from the previous literature provide the Reynolds number for various gas compositions and its relation to graphene quality. It has been revealed that hydrogen has a major influence on the fluid dynamic conditions within the CVD, hence affecting the quality of the graphene produced. Focusing on atmospheric pressure CVD, suggestions for up-scaling into larger CVD reactors while maintaining similar fluid properties were also provided.

SciVal Topic Prominence

Topic: Carbon nanotubes | Chemical vapor deposition | nanotube growth

Prominence percentile: 97.266

Author keywords

chemical vapor deposition (CVD) (deposition) fluid thin film

Indexed keywords

Engineering controlled terms: Atmospheric chemistry | Atmospheric movements | Atmospheric pressure | Deposition | Deposition rates | Electronics industry | Flow of gases | Fluid dynamics | Fluids | Gases | Graphene | Large scale systems | Reynolds number | Thin films | Vapor deposition

Engineering uncontrolled terms: Atmospheric pressure chemical vapor deposition | Atmospheric pressure CVD | Chemical vapor depositions (CVD) | Deposition kinetics | Homogeneous thin film | Influence of fluid | Large scale productions | Processing parameters

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