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In situ kinetic studies of CVD graphene growth by reflection spectroscopy

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Monitoring of large-scale synthesis of two-dimensional materials (2DMs) such as graphene is a prerequisite for industrial applications. Chemical vapor deposition (CVD) is currently the most widespread synthesis method as it is efficient and easy to automatize. The process itself is quite complex and poorly understood, but it is generally believed to involve a number of distinct steps such as hydrocarbon decomposition into surface-bound intermediates, diffusion on the catalytic substrate, generation of nucleation points and, finally, graphene growth. In situ monitoring and tailoring of such a complex procedure is beneficial for understanding the growth kinetics and, eventually, for controlling the graphene growth. Herein, we report on a novel metrology system based on in situ reflectance spectroscopy that has been developed for real-time monitoring of surface changes during graphene growth on Cu foils at high operating temperatures. The implementation of this technique for extracting kinetic parameters of the growth process is presented. Furthermore, a microkinetic model of graphene growth based on density-functional theory (DFT) and the hindered translator/rotator model for enthalpy and entropy corrections is constructed and used to obtain a microscopic understanding of the apparent activation energy and related rate-determining steps in graphene.

References

[1] C. Tsakonas, A.C. Manikas, M. Andersen, M. Dimitropoulos, K. Reuter, C. Galiotis, Chemical Engineering Journal, 421, 129434, 2021