Scalable Chemical Vapour Deposition of Monolayer Graphene Films on Iron

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Two dimensional (2D) materials, in particular graphene and 2D hexagonal boron nitride, are considered as ultimately thin functional corrosion barrier coatings for metal alloy surfaces such as steel. One factor prohibiting the implementation of such coatings is the lack of scalable routes for large area, low defect, monolayer graphene growth providing complete coverage of and good interfacing with the metal surface.Even though considerable efforts were made to coating steel substrates with graphene, to date only coatings with rather poor quality and or limited coverage have been shown. Importantly, even on pure iron (Fe), the parent phase for all steels, to date no monolayered graphene films with complete coverage have been reported, let alone under scalable conditions. This shows the clear need for a scalable process for high quality monolayer graphene growth on iron, also as a basis to understand the complex iron-carbon system as a prerequisite to advance to grow graphene on the multi-element, multi- phase system of steel substrates.
Here we report a scalable chemical vapour deposition (CVD) process that yields unprecedentedly high quality monolayer graphene films on Fe substrates with a coverage of 60-80%. We also investigate the underlying growth mechanisms via in-situ investigations into the dynamic and complex substrate phase development during growth incl. in-situ X-ray diffractometry and in-situ X-ray photoelectron spectroscopy during our scalable graphene CVD conditions on iron.