# Probing the Limits of Graphene Metal Coatings

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Graphene combines several exceptional properties, which makes it uniquely suited as a coating material[1-2]: excellent mechanical stability, low chemical reactivity, impermeability to most gasses, transparency, flexibility as well as very high thermal and electrical conductivity. Moreover, graphene can be grown directly on a range of metal surfaces and is even able to cover step edges and small defects in metal surfaces in a carpet like fashion[3-5]. Here, we investigate the limitations of graphene as an effective corrosion-inhibiting coating on metal surfaces by scanning tunneling microscopy measurements and density functional theory calculations. Specifically, the hex-reconstructed Pt(100) surface is used an a probe system, since exposure of small molecules directly onto this surface will lift the reconstruction, thus allowing for in situ monitoring of coating breakdown[6].

STM measurements reveal that a single graphene layer acts as an effective coating protecting the reactive hex-reconstructed Pt(100) surface from $O_2$ exposure, and thus preserving the reconstruction underneath the graphene layer in $O_2$ pressures as high as $10^{-4}$ mbar. A similar protective effect against CO is observed at CO pressures below $10^{-6}$ mbar. However, at higher pressures CO is observed to intercalate under the graphene coating layer, thus lifting the reconstruction, without damaging the graphene layer.

The limitations of the coating effect are further tested by exposure to hot atomic hydrogen. While the coating can withstand these extreme conditions for a limited amount of time, after substantial exposure, the Pt(100) reconstruction is lifted. Anneal experiments and density functional theory calculations demonstrate that the basal plane of the graphene stays intact and point to a graphene mediated mechanism for the H-induced lifting of the reconstruction.

## References

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**Figures**

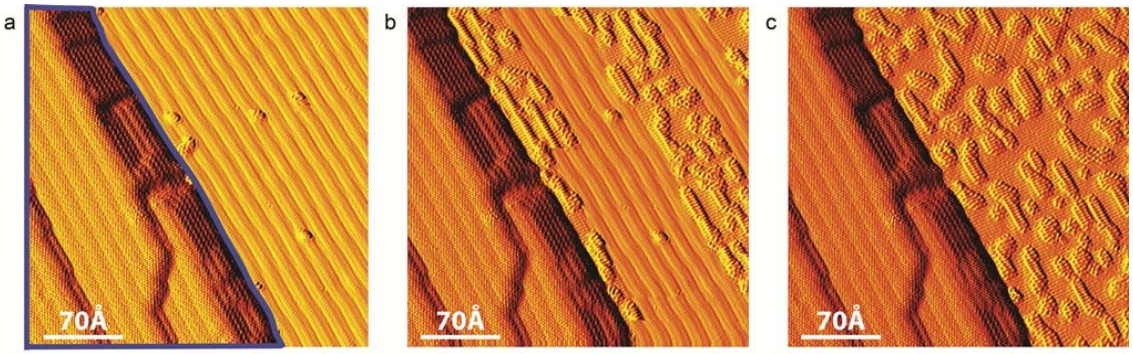


Figure 1: STM image of a Pt(100) surface partially coated by graphene. For all images, the terrace at the right side is uncoated, whereas the rest is coated by graphene (indicated by a blue boundary). The partially coated surface is exposed to (a) 0 L, (b) 3 L and (c) 63 L of CO. All the images have been differentiated to enhance the contrast. Imaging conditions [Vt , It]:[4.6 mV, 0.44 nA]. Reproduced from ref. 6.