Platinum-covered graphene as hydrogen storage medium

L. Ferbel[1], S. Veronesi[1], A. Rossi[2], C. Coletti[2], S. Heun[1]

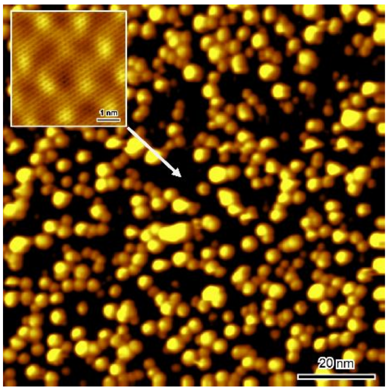
[1] *NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Piazza San Silvestro 12, Pisa, 56127, Italy*
[2] *Center for Nanotechnology Innovation IIT@NEST, Piazza San Silvestro 12, 56127 Pisa, Italy*

letizia.ferbel@sns.it

Hydrogen is the most promising green energy carrier alternative to fossil fuels. However, one of the major problems that hinders its widespread use is its storage. Graphene, in the context of solid-state hydrogen storage solutions, has attracted much attention owing to its chemical stability, low weight, large surface area, and favorable physical-chemical properties for hydrogen adsorption. Despite this, pristine graphene shows limited storage capacity at near-ambient conditions. This issue can be overcome by metal functionalization.

Among the most promising metals is platinum, which is our focus. Ab-initio calculations showed that Pt adsorbed on graphene leads to an increased binding energy of hydrogen molecules, and each Pt atom can bind up to 8 H_2-molecules allowing high gravimetric densities at near-ambient temperature [1]. Therefore, in this work, we experimentally investigated the properties and capacity of Pt-covered graphene as hydrogen storage medium.

We used monolayer graphene epitaxially grown on SiC(0001) onto which we deposited various amounts of Pt. Scanning tunneling microscopy was employed to evaluate, as a function of deposition time, the Pt amount, coverage, and distribution. To study the hydrogen storage capacity of the system, we exposed the Pt-covered graphene samples to molecular hydrogen (5 min of deuterium at $1{\cdot}10^{-7}$ mbar). We then recorded the hydrogen thermal desorption spectra. The desorption spectra shown in Fig. 1 demonstrate the suitability of Pt-covered graphene for hydrogen storage applications: while for the pristine sample no hydrogen desorption is detectable, with increasing Pt-coverage we observe an increasing hydrogen uptake. The hydrogen binding is stable at room temperature, with hydrogen desorption already occurring at temperatures moderately close to room temperature.



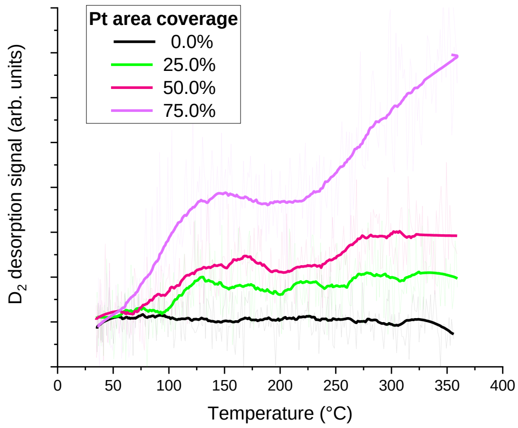


Fig. 1. STM image corresponding to a Pt area coverage of 50% (inset shows the pristine graphene structure in the areas uncovered by Pt) and desorption spectra measured for different amount of platinum.

[1] I.-N. Chen *et al.*, Applied Surface Science, **441**, 607-612 (2018)