

Water below graphene?

Chemical reactions confined to near atomic scales have many hypothesized applications. The demand for ever smaller electronical components with superior electric properties for example requires atoms to group in specific shapes that can only be cast in confined spaces. Biological cells are an example of confined reactions in the nature. Hence, in order to recreate those processes, to develop better medicine and to eventually create artificial cells, reactions at nanoscale are inevitable. Due to these promising theories, research into nano scale chemistry has increased in the past years and the name 'Nano Reactor' has become popular to describe the spaces in which those reactions can be initiated.

In order to achieve confinement to such a small space, graphene, which is a material that consists of only one layer of carbon atoms is of big importance. This incredibly thin material can be attached to metal and the space between the two can be used as a nano reactor.

If this system is exposed to oxygen, the oxygen will attach to the metal and creep underneath the graphene film. Now there is a layer of oxygen between the metal surface and the graphene. If hydrogen is dosed next, water forms underneath the flakes and stays there.

However, if we are attaching more carbon atoms on top of the graphene, we can form little clusters that are pinning parts of the graphene down to the metal surface. I am studying how those little clusters on top are changing the water formation processes underneath the flake.

My work showed that if the water-formation-experiment is performed at 45 °C, the same reactions as before happens and water can be found underneath the graphene flakes. But if the experiment is performed at higher temperatures around 75 °C, no water can be observed underneath the graphene.

Both, hydrogen and oxygen can move in the space between the metal and the graphene with and without additional carbon clusters. That means, that the water must have formed in both cases and stayed at 45 °C and left from underneath the graphene flakes at 75 °C. Hence, the pinning-down carbon clusters above the graphene are making it more uncomfortable for the water molecules. At 45 °C, the water molecules are missing the energy to break away, whilst at higher temperatures, they gain this energy.

That means, that by changing and adding clusters to the graphene from above, we can change how chemical reactions happen below, which is exciting because it gives us one more parameter to fine-tune future nano-reactors.