Graphene as a cluster sensor: detecting size-specific charge transfer and oxidation of few-atom Au\textsubscript{n}

Jeroen E. Scheerder
S. Liu, V.S. Zharinov, N. Reckinger, J.-F. Colomer, H.-P. Cheng, E. Janssens and J. Van de Vondel
Laboratory of Solid-State Physics and Magnetism, KU Leuven, Leuven, Belgium
jeroen.scheerder2@kuleuven.be

Graphene’s high susceptibility to adsorbed (nano-)particles makes it of great interest for sensing applications, and it provides schemes to tailor graphene’s properties for example for spintronics and catalysis. Ultrasmall metallic clusters are interesting candidates in this perspective. Their physico-chemical properties, which greatly differ from the element’s single atom or bulk characteristics, strongly depend on the exact number of atoms. It is expected that these size-specific cluster properties will transpire in graphene’s electronic properties. Thus on the one hand, graphene can act as a sensor to clusters, while on the other, the virtually endless possibilities to tune a cluster’s properties, greatly expands the opportunities for graphene-based cluster devices.

In order to bring these fascinating low-dimensional systems together, we introduced size-selected few-atom metal gold clusters as adparticles to graphene devices, in a novel technical realization which offers high control over the type of clusters and deposition parameters [1].

Moreover [2], we demonstrate the binding of molecular oxygen to Au\textsubscript{n} clusters deposited on graphene (Figure 1). This is an important aspect of the catalytic behaviour of these ultrasmall Au clusters. Furthermore, size-specific charge transfer can be resolved in these systems (Figure 2). To the best of our knowledge, there has been no prior realization of a device, in which the rich size-dependence of few-atom clusters is transpired in its properties.

References

Figures

**Figure 1:** Schematic overview of the experiment, where size-selected Au\textsubscript{3} clusters are deposited on graphene, followed by in-situ oxygen adsorption. The resulting graphene-cluster charge transfer is detected electronically.

**Figure 2:** Doping of oxidized Au\textsubscript{3} and Au\textsubscript{6} clusters, detected as a shift in graphene’s charge neutrality point as a function of the deposited cluster density. Reproduced experiments on different devices reveal size-specific effects, quantified by the doping efficiency $\varepsilon$. 