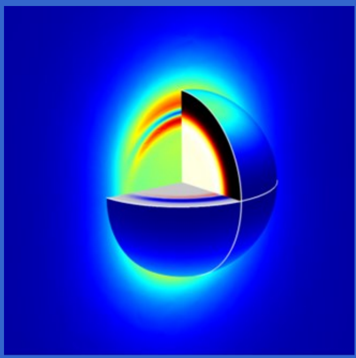
Center for Nanostructured Graphene

CNG NEWSLETTER

June, 2015

RESEARCH NEWS

In classical optics, the interaction of metal particles with light can be expressed using the refractive index of the metal. An important question in nanoplasmonics is when this classical theory breaks down and what new effects, perhaps quantum effects, start to play a role.



Electric field and charge densities in a nanosphere, based on the self-consistent hydrodynamic theory by Toscano et al.

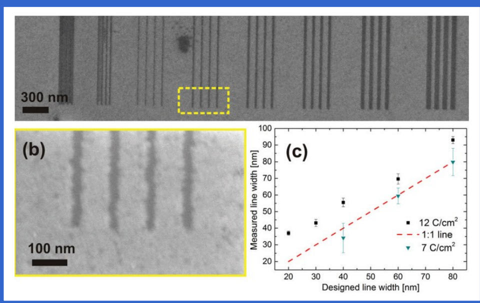
For tiny metal nanoparticles, the classical theory predicts that the optical resonances will not depend on the particle size, but only on its shape. But this is not seen when shining light on few-nanometer sized metal particles. Instead, for noble metals such as silver and gold, the resonances of smaller particles move to higher frequencies ("blueshift"), while for so-called simple metals such as sodium the resonances shift instead to lower frequencies ("redshift").

Until now these phenomena could only be reproduced with quantum mechanical ab-initio calculations, which are numerically very costly. Giuseppe Toscano and co-authors from Germany, China, and Denmark have now developed a simpler hydrodynamic theory for light that also predicts the observed frequency shifts. This increases our understanding of the origin of these frequency shifts. And since the new hydrodynamic calculations are less heavy, they can be used to make accurate predictions for more and larger structures than before.

[Nature Communications 6, 7132 (2015)]

RESEARCH NEWS

Modifying graphene physical properties through nanopatterning is challenging, since most methods either involve polymer masks or are painfully slow. Electron beam lithography has the resolution and the speed to quickly pattern sizable areas of graphene, but the inevitable contact with polymer masks leads to hard-to-remove residues that in turn cause degradation of the electronic properties. Alberto Cagliani from DTU and Niclas Lindvall from Chalmers Technical University set out to try a new approach to graphene nanopatterning. They used an intense, highly focused electron beam aimed directly to supported graphene, hoping to knock out carbon atoms directly, to define the patterns. The result was different than expected: the supported graphene was not removed, merely damaged. As it turned out, a mild oxygen treatment was found to remove just the damaged graphene, and this lead to the final, desired result - a highly dense pattern of graphene holes - without the use of polymer masks or solvents. This method is convenient for rapid prototyping of graphene structures, with a fast turn-around time and very little contamination of the graphene, and a resolution that may rival the best that conventional electron beam lithography can offer. The article was chosen as a "hot article" in the journal Nanoscale, and featured in the Nanoscale science blog.



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