Keynote

Silicon colloids. Properties and applications to metamaterials, sensing and solar energy harvesting

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Recently, we have developed silicon colloids (SCs) [1,2] with particle size between 200 nm and 3000 nm. Silicon has an extremely high refractive index value, so SCs behave as optical microcavities in the near IR region. Here we will report on the following applications.

1. Silicon colloids based Raman enhanced sensors.
Silicon colloids have huge values of the light scattering cross section, and therefore a huge the evanescent fields around the nanoparticles. We have developed Raman enhanced chemical sensors based on silicon nanoparticles with Raman signal enhancement factor similar to that shown for gold nanoparticles. At variance to gold silicon is very cheap to produce (1000 times cheaper) and it biodegrades very easily into the natural chemical species (polysilicic acid) of the human body [3].

2. Silicon colloids based metamaterials.
Here we report on the large magnetic response of SNs in the NIR region with small optical losses [2,4]. We also have developed a two dimensional photonic crystal, which shows a perfect optical matching condition in the NIR region. Our findings have important implications in the bottom up processing of large area low loss metamaterials working in the NIR region.

3. Silicon nanocavities for Mie enhanced photodiodes.
SCs constitute a very promising platform for developing a p-n junctions solar cells able to overcome the well known classical Shockley–Queisser (SQ) limit [5]. Here we show the first example of a photodiode developed on a micrometer size silicon spherical cavity. The long dwell time of resonating photons enhances the absorption efficiency of photons at the IR region well below the absorption edge of silicon [6].

References

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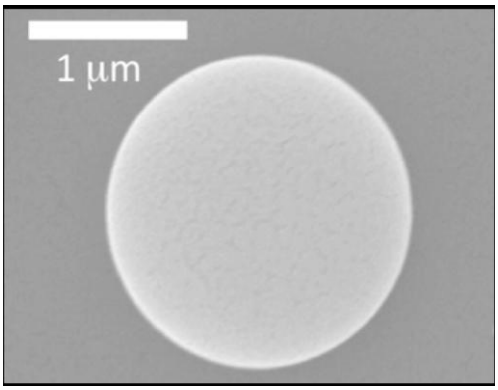

Figure 1. Spherical nanocavity made of polycrystalline silicon.