Silicon nanocavities. Optical properties and applications

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Silicon is the key enabling material for advanced technologies in electronics, and photonics. Recently, we have developed silicon nanocavities (SNs) [1,2] with particle size between 300 nm and 3000 nm. Silicon has an extremely high refractive index value, so SNs behave as optical microcavities in the near IR region. Here we will report on the following applications of SNs.

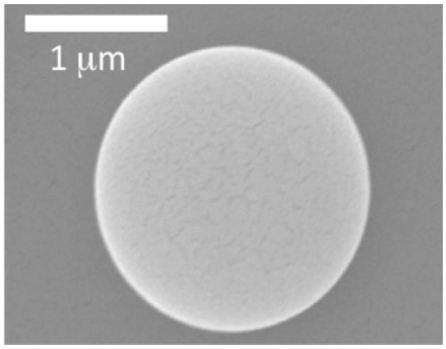

Fig. 1. Spherical microcavity made of polycrystalline silicon

1. SNs based sun radiation blockers.

SNs have huge values of the scattering cross section, much larger than the particle size. A coating of SCs, 10 micrometer thick, blocks 99% of the UV, VIS and IR radiation coming from either, the sun or any other hot body. Therefore SCs may have applications as UV, VIS and IR coatings and pigments [3].

2. SNs based metamaterials.

Theory shows high refractive index dielectric nanomaterials may show strong magnetic response in the optical region [4]. Here we report on the large magnetic response of SNs in the NIR region with small optical losses [2,5]. 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 colloids for Mie enhanced photodiodes.

SNs constitute a very promising platform for developing a p-n junctions solar cells able to overcome the well known classical Shockley–Queisser (SQ) limit [6]. 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 [7].

References.

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