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Bio-inspired holey submicrometer plasmonic core-shell particles as generalized synthetic brochosomes

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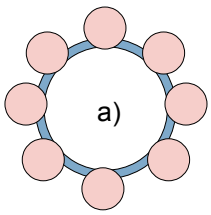
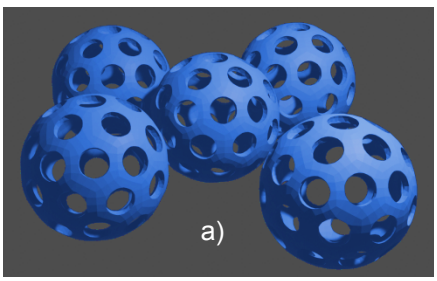
- **Brochosomes** are aperture-riddled submicrometer **hollow spherical submicrometer particles** usually consisting of proteins and lipids. They are produced by some insects (e.g. leafhoppers – Hemiptera: Cicadellidae). They simultaneously perform a role of superhydrophobic protection against sticking the insect to plants sap and serving as antireflective coatings in the visible to reduce observability by predatory species (a natural **cloaking device**).
- Attracting researchers' attention by their multifunctionality, brochosomes had been artificially produced in various materials, including among others plasmonic materials. From the photonics point of view, so far they have been used as **omnidirectional ultra-antireflective diffractive coatings** in a wide frequency range and as photoanodes in photoelectrochemistry.



Blue annulus: plasmonic shell.
Pale pink spherules: sacrificial structures to be etched, leaving the holey shell
White: hollow core

Schematics of synthesis of artificial holey core-shell particles: sacrificial spherules are first built into the core during deposition and then etched away.



3D model of the resulting artificial holey core-shell particles

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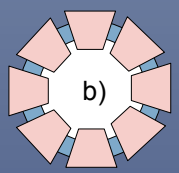
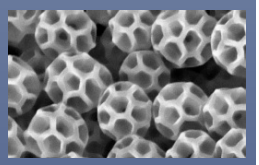
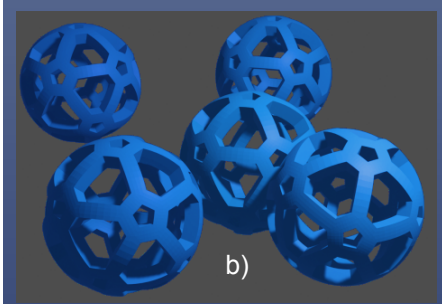
- **In this work we propose generalized geometries of synthetic brochosomes containing free-electron conductors (i.e. plasmonic materials).**
- **Synthetic brochosomes were first fabricated by depositing sacrificial nanospheres on the plasmonic shells of core-shell submicrometer particles at various depths and then etching them, leaving rounded surface holes. Such a procedure was proposed and described by S. Yang et al, *Nature comm*, 8, 1-8, 2017.**
- **Here we extended the range of possible designs and geometries and performed simulation of the electromagnetic scattering parameters of the newly proposed structures using the finite element method.**
- **We succeeded in obtaining omnidirectional ultralow reflection in an extended wavelength range while simultaneously achieving high geometry and material-based control over frequency shifting and shape of the spectral characteristics of scattering parameters.**





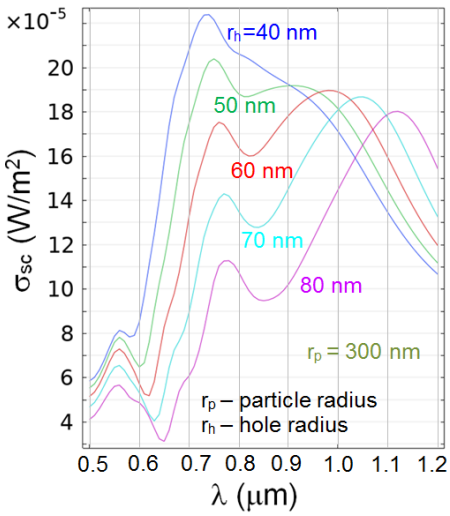
Schematics of synthesis of biomimetic core-shells

SEM of natural brochosomes (Oncometopia orbona)

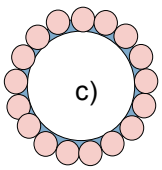


3D model of artificial brochosomes mimicking the natural ones (of Oncometopia orbona)

An advantage of the **generalized design** of plasmonic-based artificial brochosomes is their multifunctional applicability. At the same time they are antireflective, superhydrophobic and highly porous, their parameters controllable by design. This could be of interest for numerous MEMS and MOEMS systems.

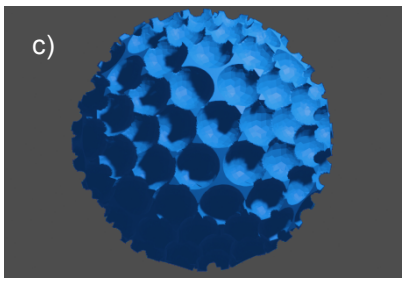


FEM-calculated spectral scattering cross-section (not normalized) of the structure (a) chosen as an example. Plasmonic shell material is gold



Schematics of synthesis

SEM of natural brochosomes Homalodisca coagulata)



3D model of artificial brochosomes mimicking the natural ones (of Homalodisca coagulata)

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