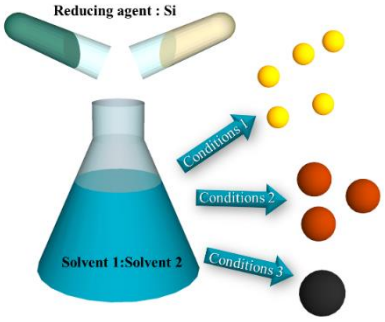
SOLUTION SYNTHESIS OF SILICON PARTICLES FOR OPTICALLY ACTIVE METAMATERIALS

Silicon has exceptional properties of interest to batteries, semi-conductors, electronics and optics. If it were possible to control the physical characteristics of silicon nano-objects, a host of possible applications would become possible in visible and near-infrared technologies due to the exceptionally high refractive index and low light absorption. Their assembly into a material would lead to metamaterials, materials with sub-wavelength dimensions displaying properties that are not observed in nature. Optical behavior in a metamaterial results from the composition and structural organization of a material. Metamaterials can shape an incoming or outgoing wavefront. Due to its low light absorption and high refractive index across the visible spectrum, crystalline silicon is the most desirable known material for optical metamaterials. Light is captured, concentrated and redirected by silicon particles thanks to a phenomenon called Mie resonance. This optical resonance within a particle is similar to how the sound of a plucked string is amplified via the acoustic resonance of a guitar.

The objective of this study is to create silicon spheres via wet chemistry (see Figure). Particle nucleation, growth, and coalescence will be the phenomena used to tune particle size and size dispersion. Bulk quantities of these sub-micrometric particles will be produced thanks to the scalability of solution syntheses. Silicon coordination compounds will be synthesized and decomposed under air- and water-free conditions. Small particle seeds can be grown into larger particles via a step-wise addition of the silicon precursor molecule. Reducing agents, solvent and reaction conditions will be adjusted to favor particle growth.



Once these silicon objects are realized, they will be processed into a material, using elastomer films and fibers. Films will be prepared via doctor-blading, spin-coating or dip-coating. Fibers will be spun using electrospinning. Obtaining high particle loadings within the polymer matrix will be the challenge. The optical scattering properties of both individual particles and the materials will be fully characterized.

By the end of the thesis, the PhD candidate will be competent in nanoparticle and microparticle synthesis and characterization (TEM, SEM, DLS, IR and Raman spectroscopy), material fabrication (dip-coating, blade-coating), optical characterization (dark-field optical microscopy) and simulating optical spectra.

Candidate Profile
For this study, a chemist or material scientist with synthetic interests is needed. Skills working under air-free conditions using a glove box and a Schlenck line and with pressurized systems are desired. Ideally, the candidate will have experience in several of the following characterization techniques: XRD, electron microscopy (TEM and SEM), porosimetry and optical spectroscopy. **A high level of scientific English, ambition and curiosity are required.**

Starting date, duration
A Stage M2 (5 or 6 months) is available starting from January. This can continue as a PhD thesis, starting between September and December, 2021, for a duration of 36 months.

Localization and Supervision
The M2/thesis student will participate in the ERC funded project *Scatter* under the supervision of Dr. Glenna Drisko (https://glennadrisko.com/). She or he will be integrated into the *Chimie des Nanomatériaux* group (http://www.icmcb-bordeaux.cnrs.fr/spip.php?rubrique27) in the « Institut de Chimie de la Matière Condensée (ICMCB – CNRS UPR 9048) », in Bordeaux, France. The student will benefit from the synthetic experience of the host team as well as the material fabrication and optical characterization expertise in the project consortium. The student will interact with post-docs and other students in the group to quickly advance the synthesis of silicon particles, particle assembly and optical characterization, in a highly dynamic and stimulating environment.

Application
The application will include a complete CV, a letter of motivation. Letters of recommendation can be optionally included in a single PDF with the letter of motivation. The application for the thesis should be written in English and **submitted through the CNRS website**. A first contact directly with Dr. Drisko is highly recommended (glenna.drisko@icmcb.cnrs.fr).