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# Self-assembly of Si-based particles for infrared-active metamaterials

Megan A. Parker<sup>a</sup>, Lucien Roach<sup>a</sup>, Raul Barbosa<sup>b</sup>, Maria L. De Marco<sup>a</sup>, Alexander Castro-Grijalba<sup>a</sup>, Brian A. Korgel<sup>b</sup>, Patrick Rosa<sup>a</sup>, Mathieu Gonidec<sup>a</sup>, Sabrina Lacomme<sup>c</sup>, Vasyil Kravets<sup>d</sup>, Alexander N. Grigorenko<sup>d</sup>, Philippe Barois<sup>e</sup>, Virginie Ponsinet<sup>e</sup>, Glenna L. Drisko<sup>a</sup>

<sup>a</sup> CNRS, Université de Bordeaux, Bordeaux INP, ICMCB, UMR 5026, 33600 Pessac (France)

<sup>b</sup> McKetta Department of Chemical Engineering, The University of Texas at Austin, Austin TX 78712 (USA)

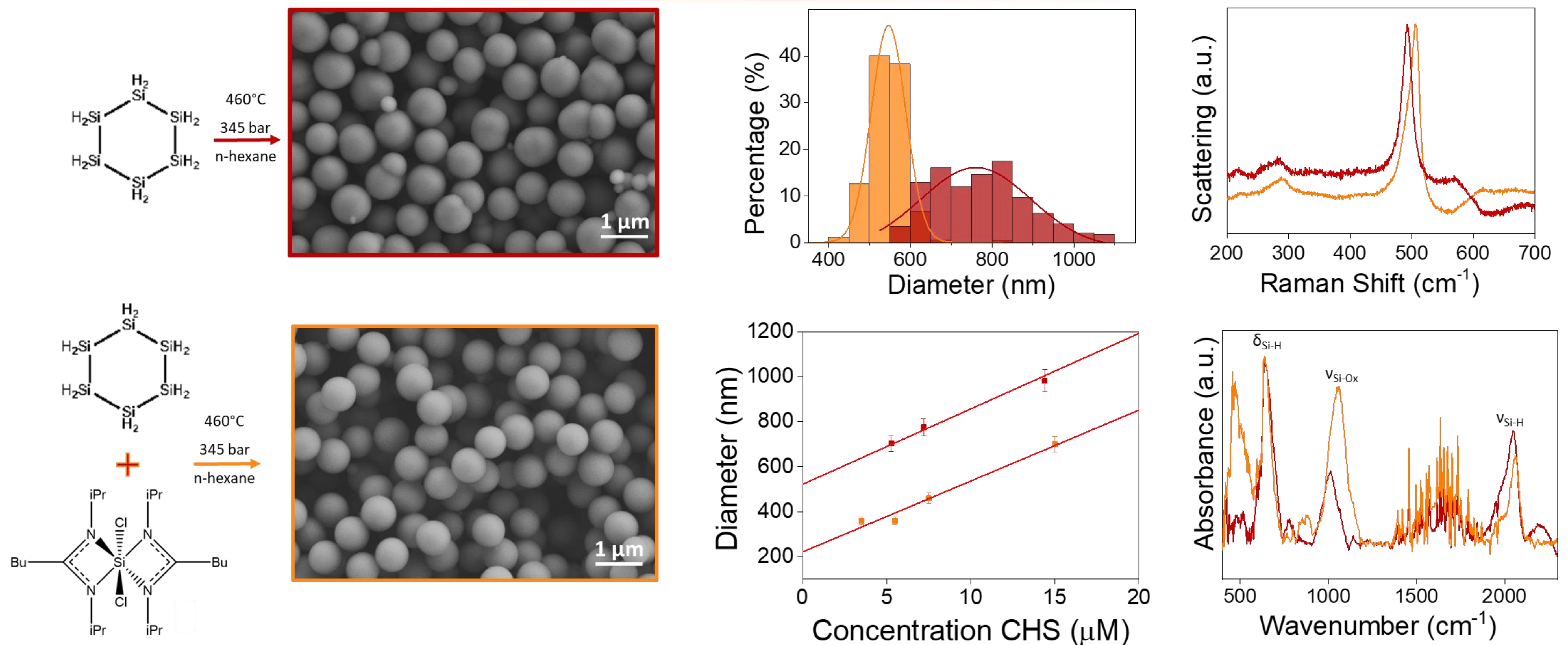
<sup>c</sup> Université de Bordeaux, Bordeaux INSERM, BIC, UMR 3420, 33000 Bordeaux (France)

<sup>d</sup> Department of Physics and Astronomy, Manchester University, Manchester M13 9PL (UK)

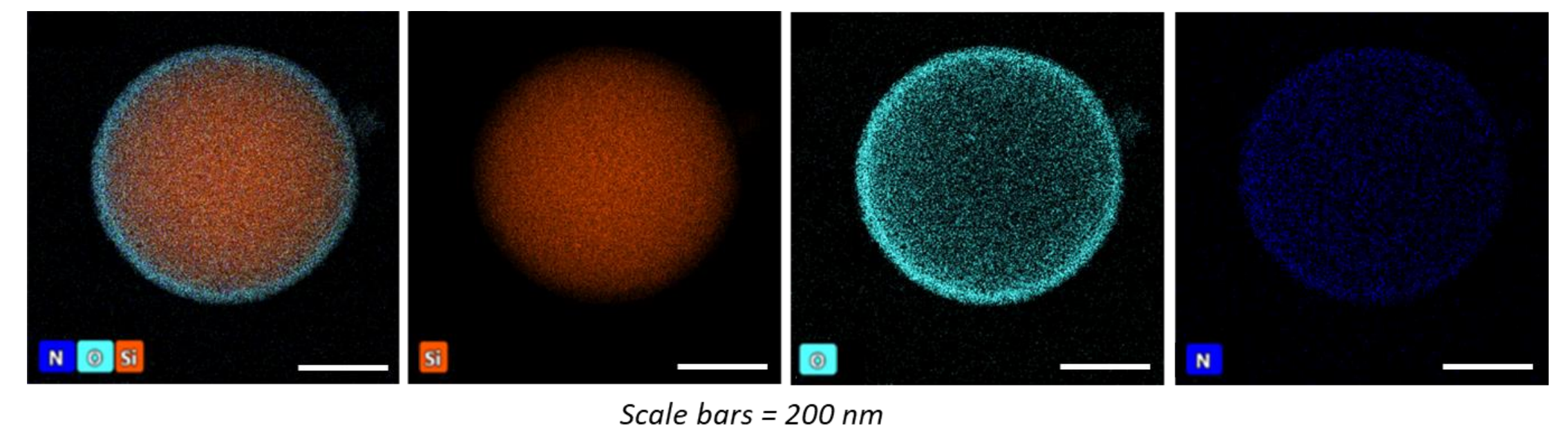
<sup>e</sup> CNRS, Université de Bordeaux, Bordeaux INP, CRPP, UMR 5031, 33600 Pessac (France)

**Context:** Si-based particles are synthesized from cyclohexasilane and a silicon coordination complex in supercritical hexane, a synthesis route which produces monodisperse spheres with control over particle size. A solution-based self-assembly method deposits the particles into a close-packed monolayer and optical properties are measured. Mie Theory calculations of single particles are compared to ellipsometry measurements of films of particle assemblies. We demonstrate that a this material, synthesized from an entirely bottom-up approach, has high quality factor resonance in the near-IR with magnetic permeability  $\mu \neq 1$ .

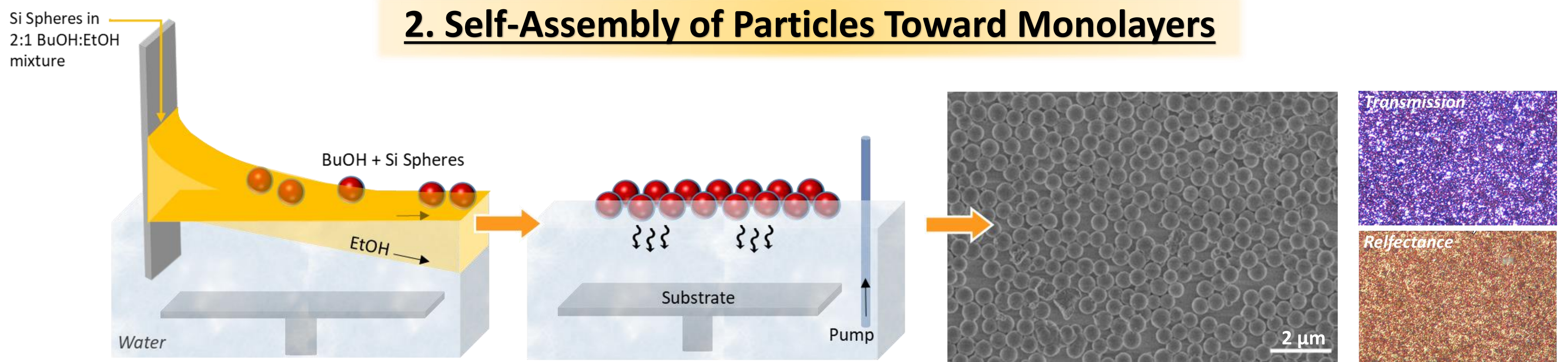
## 1. Supercritical Synthesis of Si Particles



- Supercritical synthesis produces monodisperse Si-based spheres
- Control over particle size from 400 nm to 1  $\mu\text{m}$
- Addition of silicon coordination complex to cyclohexasilane results in smaller particles and growth of thin  $\text{SiO}_x\text{N}_y$  shell

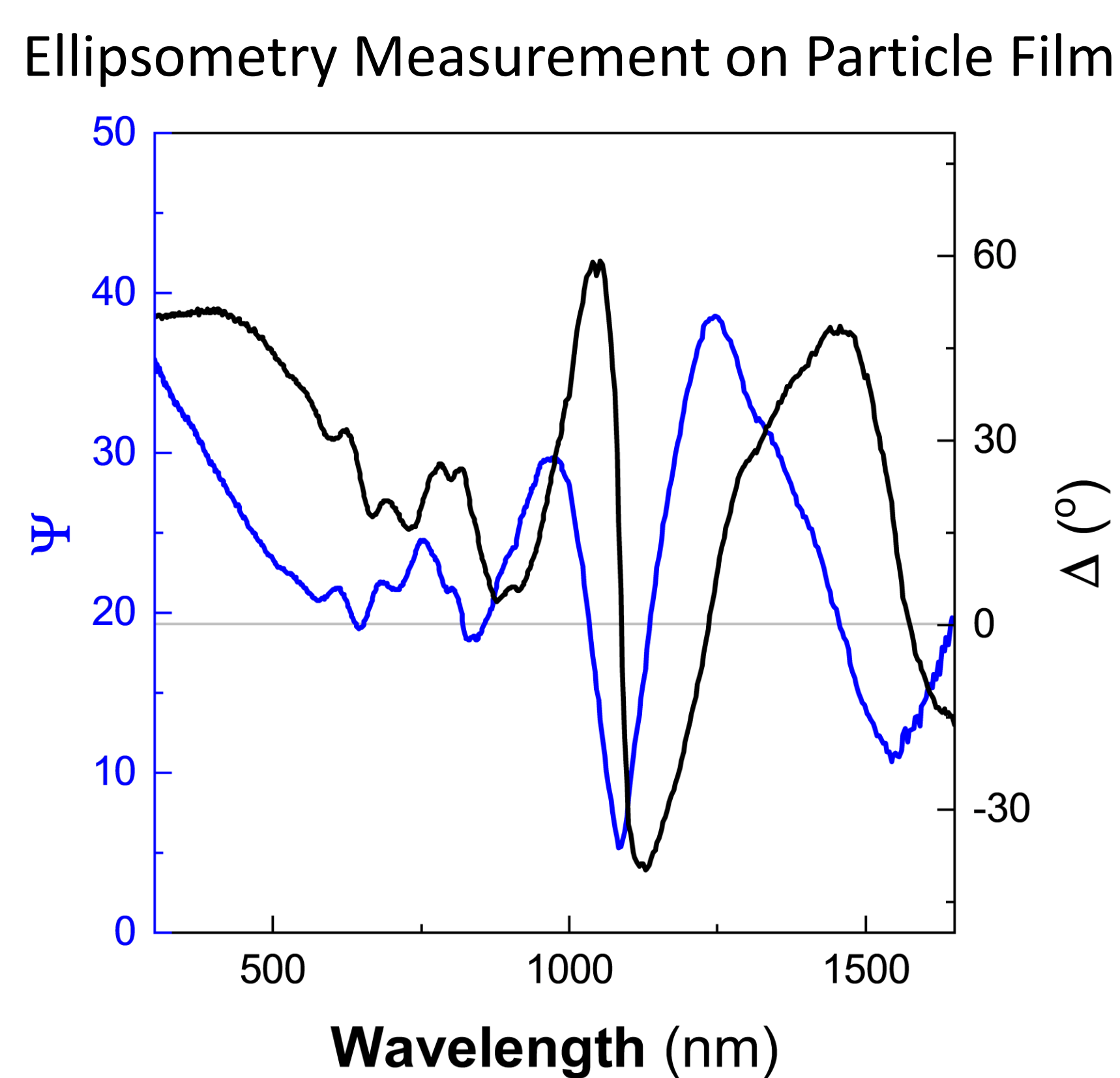
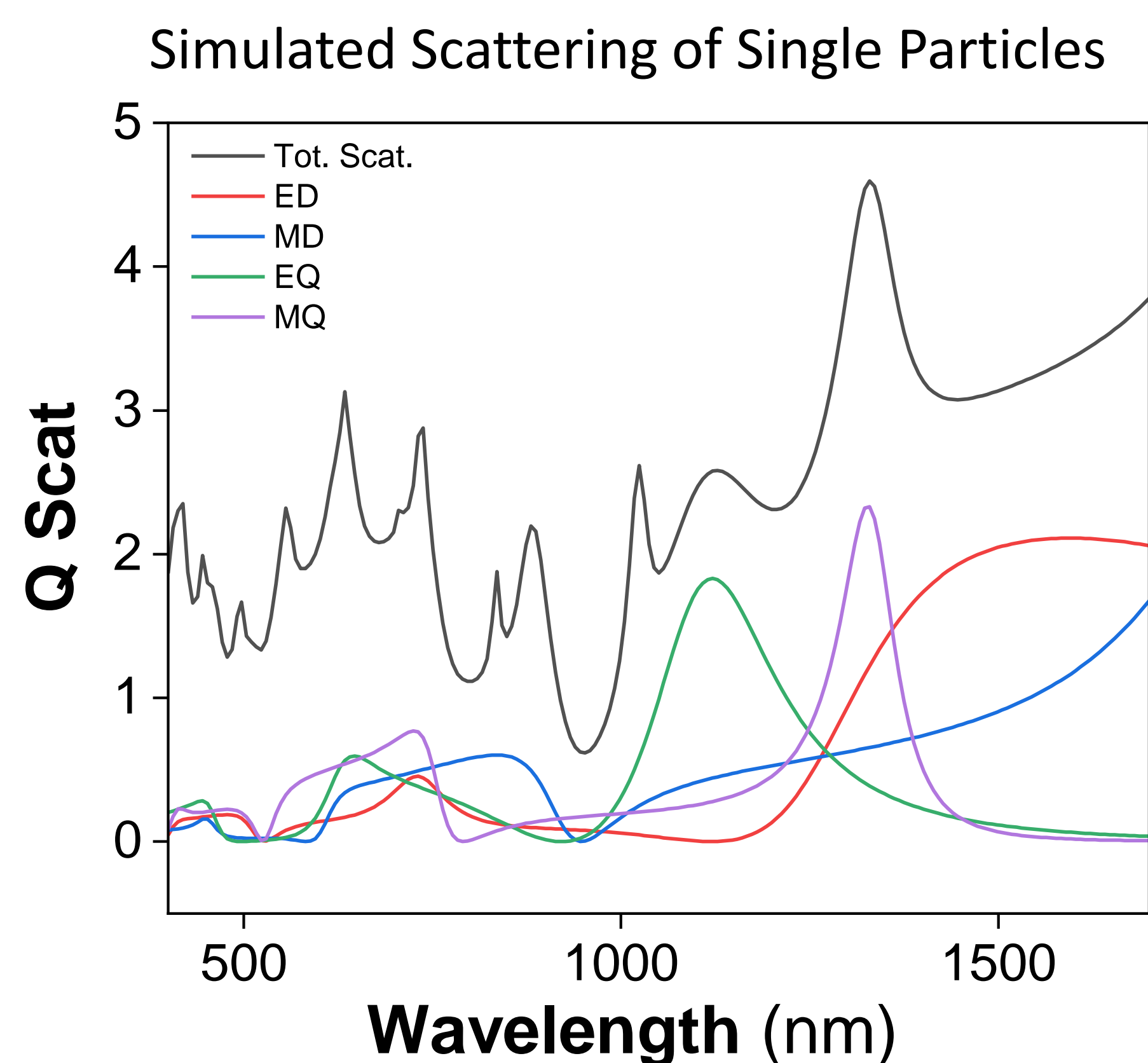


## 2. Self-Assembly of Particles Toward Monolayers



- Assembly method effective for large areas (1  $\text{cm}^2$ )
- Produces closely-packed particles - silica shell serves as spacer between resonators
- Films transmit purple light, while red light is reflected

## 3. Optical Characterization



### Key Points:

- Intense resonances observed at near-IR wavelengths
- Resonances are not quenched when particles are assembled
- Metamaterial with high quality factor magnetic resonance (Q)