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

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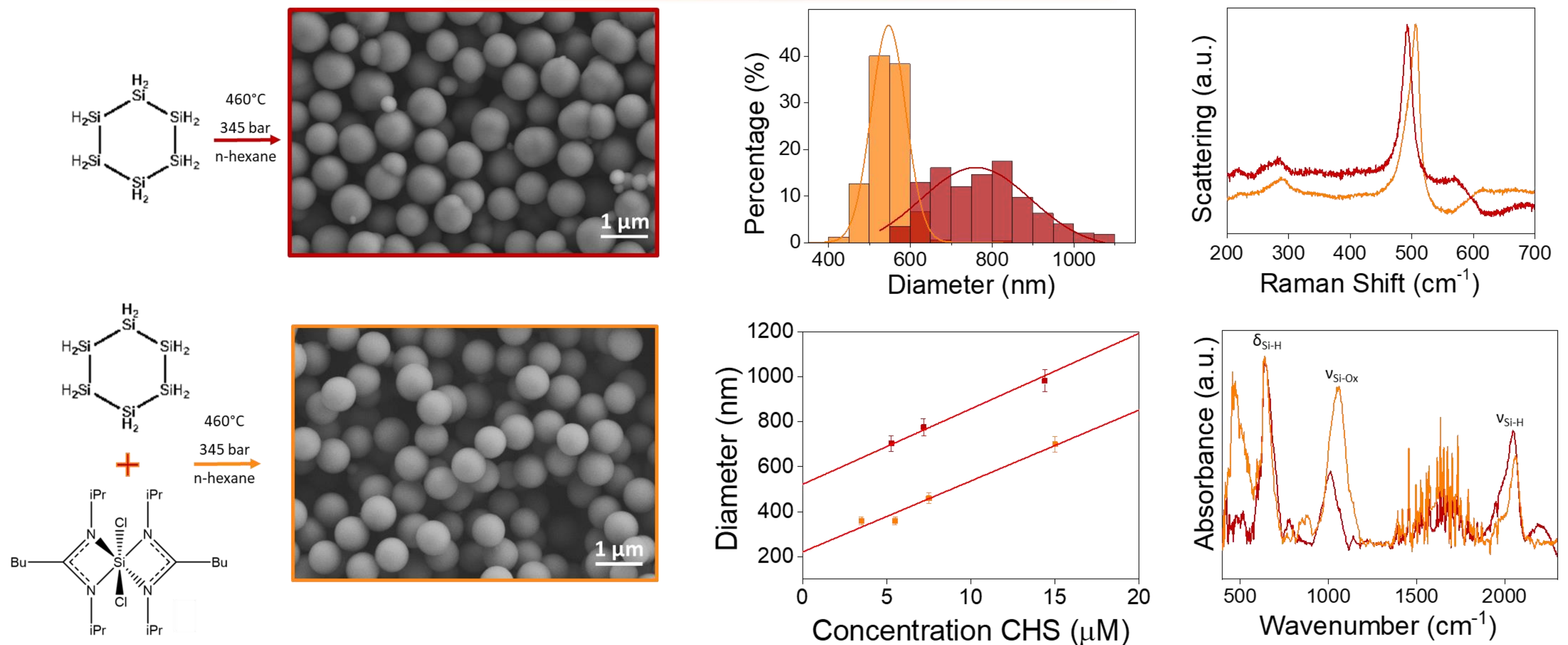
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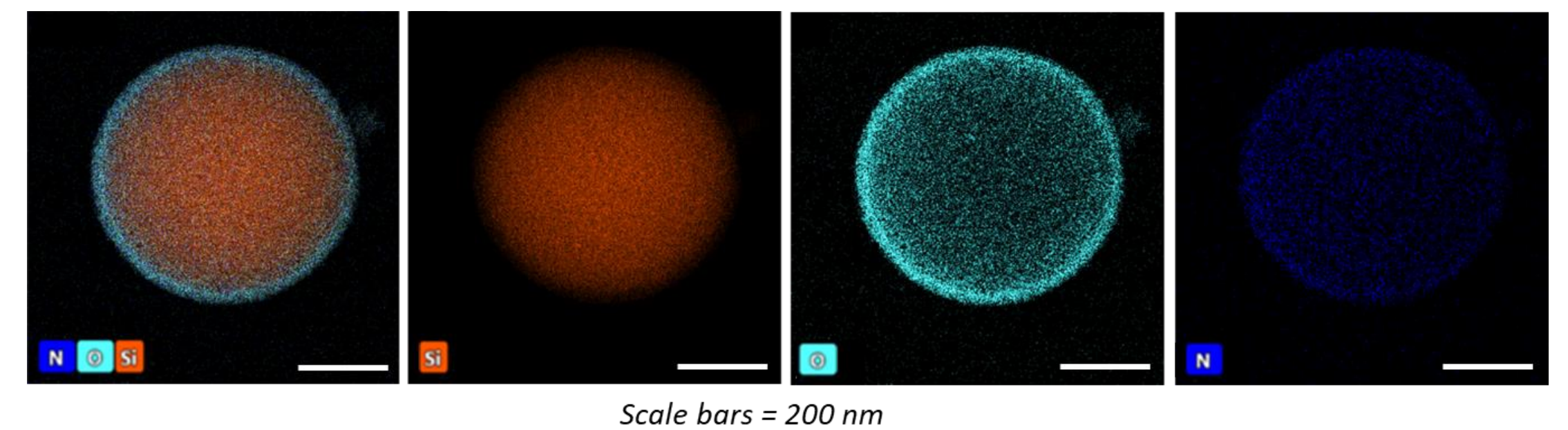
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Context: Si-based particles are synthesized from cyclohexasilane and a silicon coordination complex in supercritical hexane, a synthesis route which produces monodisperse spheres with control over particle size. A solution-based self-assembly method 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 $\mu \neq 1$.

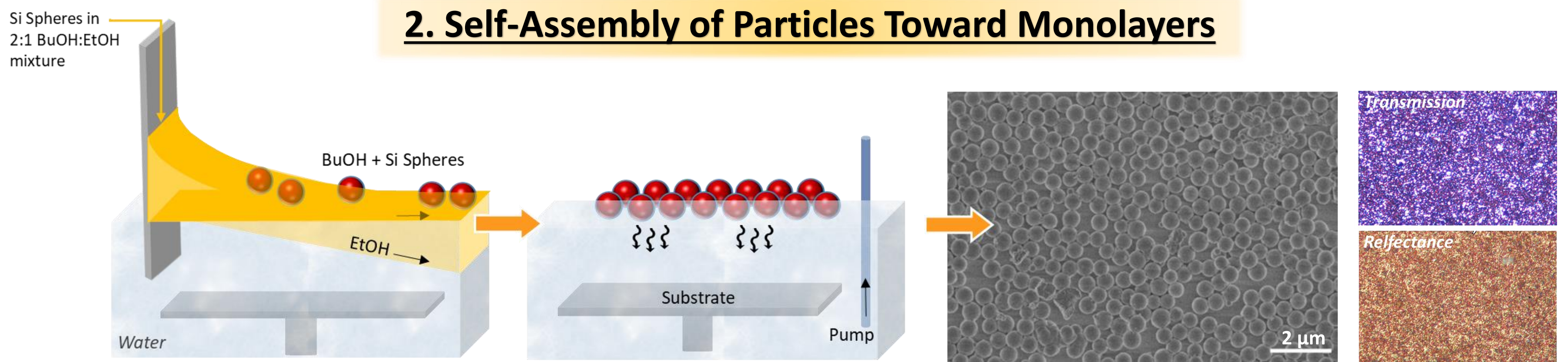
1. Supercritical Synthesis of Si Particles



- Supercritical synthesis produces monodisperse Si-based spheres
- Control over particle size from 400 nm to 1 μm
- Addition of silicon coordination complex to cyclohexasilane results in smaller particles and growth of thin SiO_xN_y shell

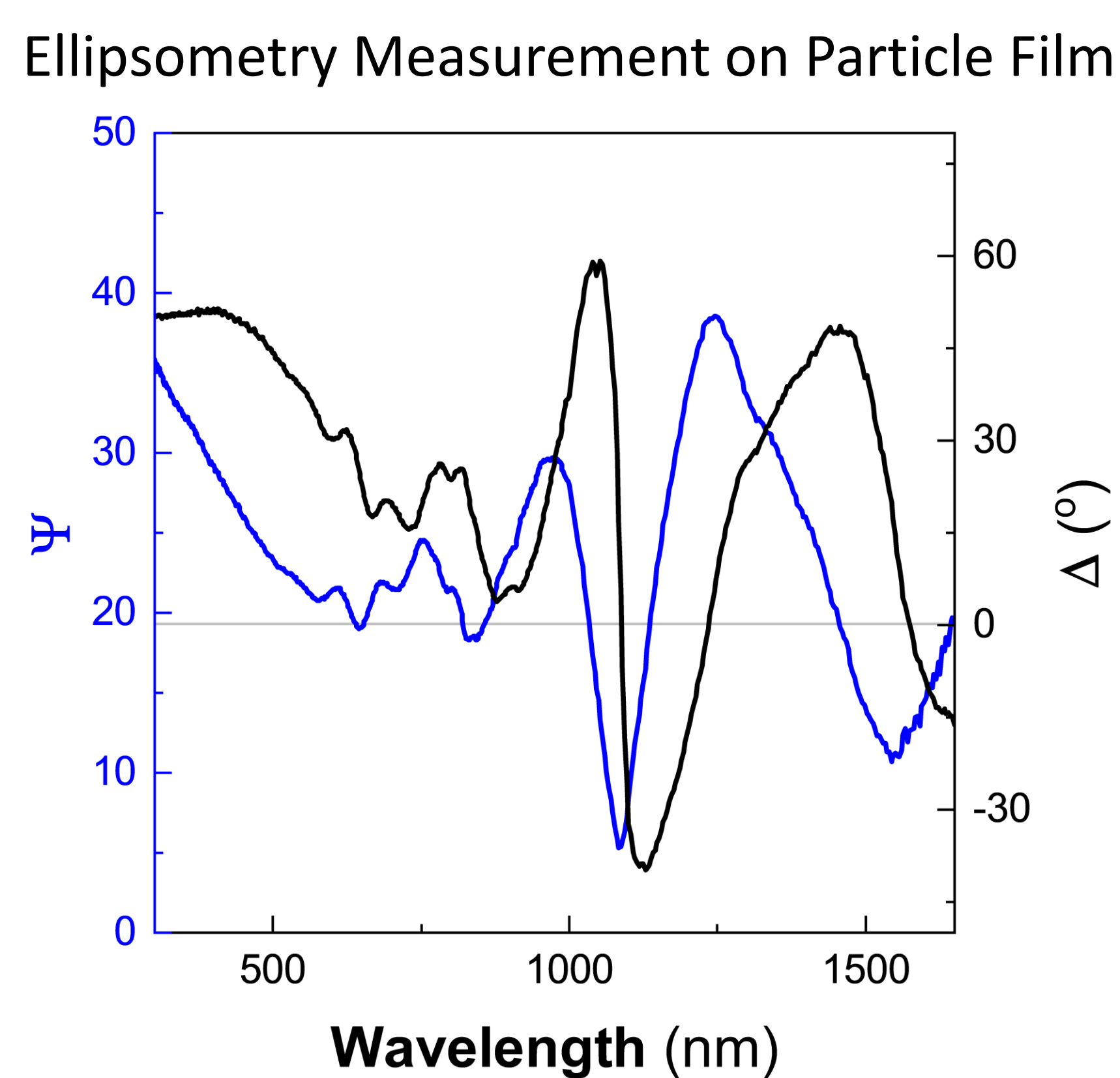
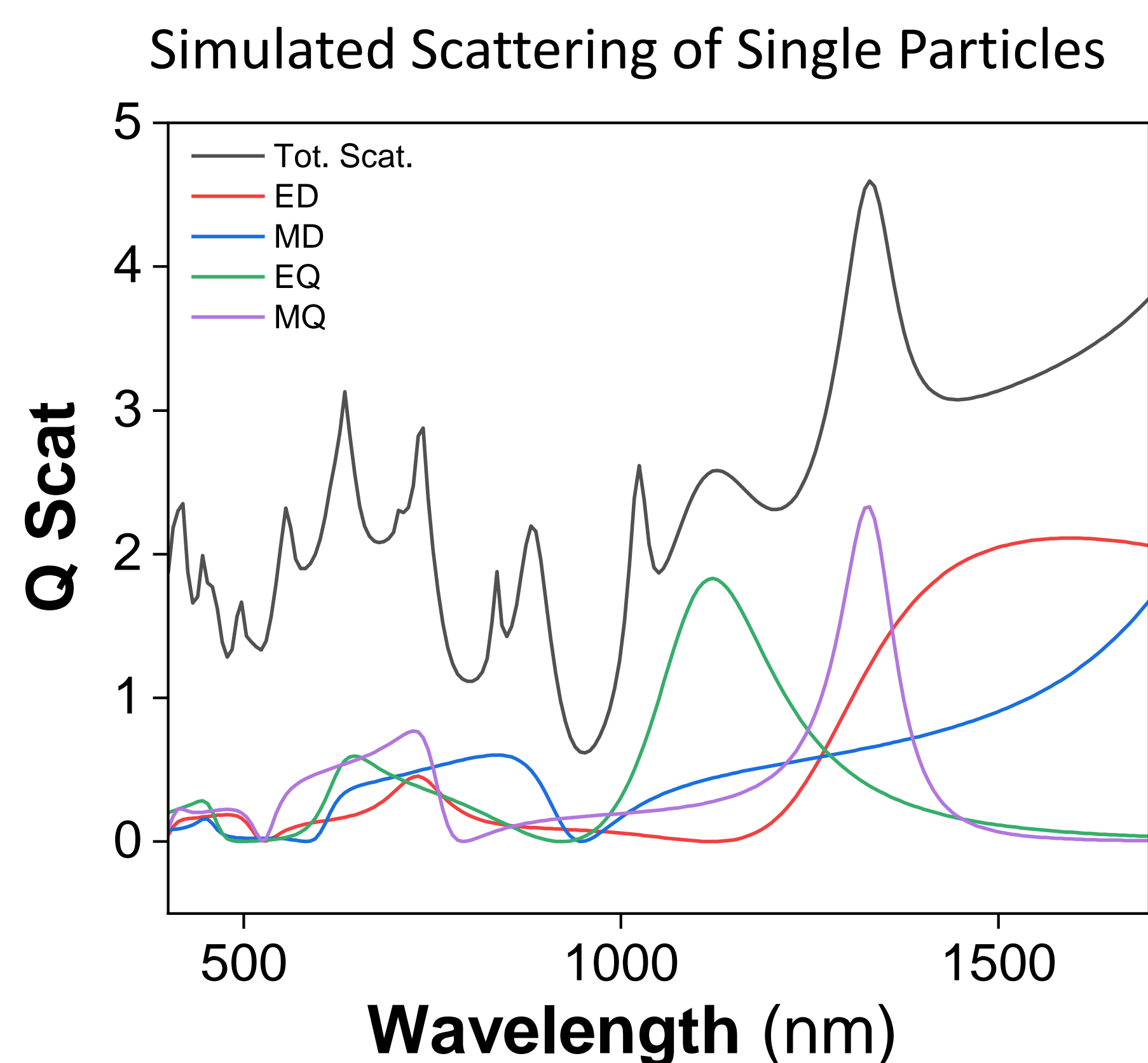


2. Self-Assembly of Particles Toward Monolayers



- Assembly method effective for large areas (1 cm²)
- 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)