Real-time characterization of shape evolution of nanoparticles

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Motivation
- The plasmon resonance property of gold nanoparticles is promising for implementing a shape-change-triggering scheme in shape memory polymers, which have applications in self-healing structures, biomedical sensors, and switches.
- Producing gold nanoparticles with well-controlled shape and size is essential for obtaining the desirable plasmon resonance property.
- However, it has also been recognized that the current synthesis process is not robust. The quality (yield, size, and shape) is very sensitive to multiple factors. The lack of robustness for the current process has not been fully understood.

Objective: The objective of the research is to study a predictive model to better understand the gold nanoparticle synthesis process in terms of nanoparticle’s size and shape evolution, and use the predictive model as guidance for reliably producing and measuring gold nanoparticles with well controlled sizes and shapes.

Approach
- Analyze and improve a nanoparticle self-assembly process as a promising synthesis method.
- Use in situ measurement instruments (in situ microscopy and in situ scattering) to analyze high dynamic and stochastic nature of nanoparticle self-assembly processes.
- Combine two complementary in situ instruments to obtain process measurements at required length and time scales.
- Analyze the multi-instrument measurements together for more statistically robust estimates of particle sizes and shapes, and their temporal evolutions.

Accomplishment

T1: In situ TEM Data Analysis
Sequence of Electron Microscopic Images
Temporally sparse but highly spatially resolving microscopic image data

T2: In situ SAXS Data Analysis
Sequence of Scattering Intensity Curves
Spatially averaging but highly temporally resolving scattering intensity curve data

T3: Data Fusion of TEM and SAXS
Model and estimate a stochastic time series of a nanoparticle morphology evolution with microscopy data and scattering data

External Grants and Relevant Journal Articles
- Park, C. (PI), and Liu, T. Dynamic Data-Driven Modeling of Nano Particle Self Assembly Processes. AFOSR through Texas A&M University. (FA9550-13-1-0075). FSU portion $267,662.

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