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RESEARCH & COLLABORATION PROFILE |

KEY WORDS: Rheology, Battery Slurry, Silicon Anodes, Interfacial Nanoslip, Polymer Composites, Biosensing



Research Snapshot. Prof. Lee combines rheology, colloid and interface science, and polymer processing to design high-performance battery electrodes and functional polymer systems. His work connects slurry microstructure and coating stability to electrochemical performance, probes dynamic nanoslip, hydration, and charge at vibrating solid-liquid interfaces using QCM, AFM, and LSPR, and develops microfluidic and membrane platforms for sensing, separation, and energy applications.

RESEARCH EXPERTISE

- **Battery slurry rheology & electrode processing:** rheology-informed formulation of silicon and high-loading electrodes using LAOS/SPP, yield, recovery, dispersion, and coating-stability analysis.
- **Conductive nanonetworks for silicon anodes:** SWCNT/CB network design, particle dispersion, defect suppression, and mechanochemical pathways for durable, high-capacity electrodes.
- **Solid-liquid interfacial dynamics:** dynamic nanoslip, hydration, ion screening, and adsorption quantified by QCM, and nano-plasmonics.
- **Polymer membranes & separators:** electrospinning, surface modification, and nanocomposites for battery safety, thermal resilience, waterproofing, and acoustic transport.
- **Microfluidics & biosensing:** droplet tensiometry, viscoelastic particle focusing, biofilm mechanics, and LSPR/QCM platforms for interfacial sensing.

RECENT RESEARCH HIGHLIGHTS

- **Mechanically adaptive CNT networks (Nano Lett. 2026):** linked CNT wall number and dispersion chemistry to stress pathways in silicon anodes; operando Raman revealed the resilient behaviour of SWCNT networks.
- **Rheology-guided silicon electrodes (Carbon Ener. 2026):** modelled Si-SWCNT slurry structure and processing windows to connect coating quality with electrode capacity and cycling stability.
- **Interfacial hydration & nanoslip (Small 2025; Adv. Func. Mat. 2026):** combined QCM, AFM, and LSPR to quantify ionic-strength-dependent nanoslip, solvation, and hydration-shell compression.

POTENTIAL COLLABORATION RESEARCH

Best-fit collaborator areas: battery materials & manufacturing | rheology & formulation | QCM/AFM/LSPR interfacial analysis | biosensing | polymer membranes

1. **High-loading silicon anodes:** develop rheology-informed formulations, adaptive CNT networks, coating diagnostics, and structure-performance relationships.
2. **Real-time interfacial characterization:** integrate QCM, AFM, and LSPR to map slip, solvation, adsorption, and charge across ionic and flow conditions.
3. **Functional membranes & separators:** engineer electrospun and nanocomposite systems for battery safety, thermal robustness, selective transport, and acoustic performance.
4. **Microfluidic and biosensing platforms:** build integrated devices for biointerfaces, biofilms, particle focusing, droplet mechanics, and low-volume diagnostics.

SELECTED RECENT PUBLICATIONS

- **Nano Lett. 2026, 26, 4782-4789 —** Interplay of wall number and mechanochemical response in carbon nanotube networks reveals the mechanism for durable silicon anodes in lithium-ion batteries.
- **Adv. Funct. Mater. 2026, 36, e12939 —** Nanoplasmonics reveal ionic-strength-driven hydration of nanoparticles.
- **Small 2025, 21, e2505067 —** Resolving nanoslip, solvation inertia, and charge dynamics at vibrating solid-liquid interfaces.
- **Carbon Energy 2026, e70280 —** Rheological modeling and optimization of Si-SWCNT anode slurry coatings for enhanced capacity and stability in lithium-ion batteries.
- **Nat. Commun. 2022, 13, 6608 —** Unraveling liquid gliding on vibrating solid-liquid interfaces with dynamic nanoslip enactment.

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REPRESENTATIVE RESEARCH THEMES

