Asphaltene Behaviors and Models

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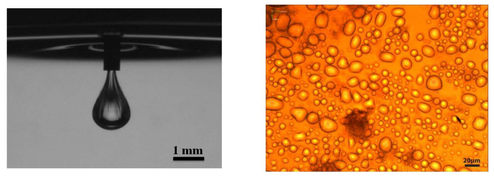
BACKGROUND

Asphaltenes are the heaviest components in crude oil. It is generally believed that asphaltenes adsorbed at oil/water interface can form a protective layer to stabilize the emulsions. Asphaltenes can cause detrimental phenomena in the oil and gas industry both in the upstream and downstream of the industry. It is of both fundamental and practical importance to understand the behaviours and models of asphaltenes at the oil/water interface.



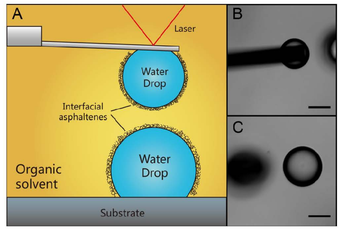
SHORT-TERM OBJECTIVES

The short-term objective is to characterize molecular and surface interaction mechanisms of bitumen and asphaltenes with minerals, water, and other additives in non-aqueous solvents using advanced tools such as drop-probe atomic force microscope (AFM), surface forces apparatus (SFA) and quartz crystal microbalance with dissipation (QCM-D). The results will be correlated to bitumen properties (TAN, SARA and viscosity). Simultaneously, molecular models of the solvents, asphaltenes and other bitumen components will be developed and validated by the experimental results. Attempts will also be made to study the interaction forces in the partially upgraded bitumen products.

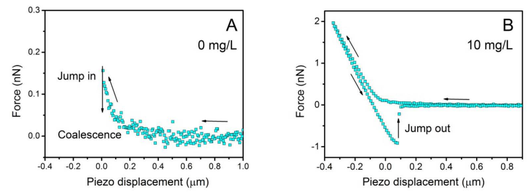
PROJECT OVERVIEW

One of the challenges for a feasible NAE process is that the final extracted bitumen product is free of water and mineral/clay solids so that it can be used as refinery feed. This project is a systematic investigation of various asphaltene behaviors and models by combining quantitative intermolecular and surface force measurements and molecular dynamics simulations in NAE processes (e.g., non-aqueous extraction, solvent recovery and product cleaning) and in partially upgraded bitumen.

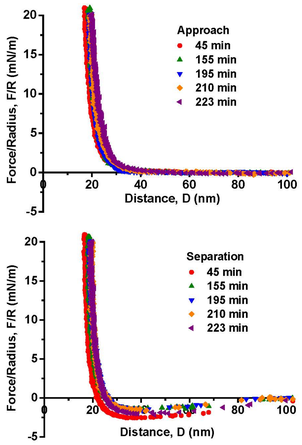
The long-term objective (>4 years) is to use the developed bitumen and asphaltene models in the non-aqueous solvent systems to guide the development of the NAE process.



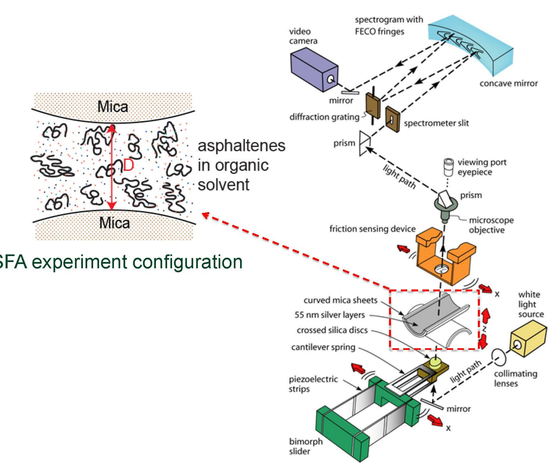
Drop-probe AFM technique



Two typical force curves of interaction obtained from drop-probe AFM between water droplets in toluene after 5 min aging in asphaltenes solution with concentration of (A) 0 mg/L; (B) 10 mg/L



Force-distance curves obtained from SFA between two model clay surfaces (i.e. mica) with asphaltenes-in-toluene solution



SFA experiment configuration

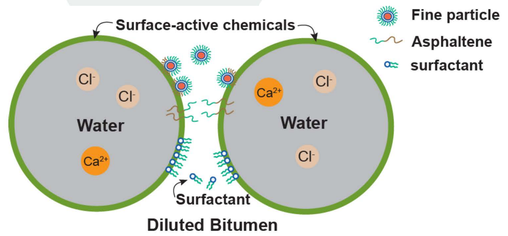
THEME OVERVIEW

Heavy Oil - Non-Aqueous Recovery

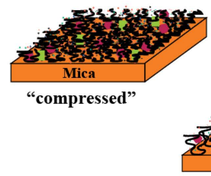
Excessive freshwater use and its eventual capture in tailings ponds represent some of the most concerning elements of the oil sands industry. The requirement for water to be heated as part of the process is also a serious concern, as it demands the use of considerable energy as part of the extraction process. Developing a Non-Aqueous Extraction (NAE) method for recovering oil from the oil sands without the use of water could significantly reduce the environmental and carbon footprint of extracting these resources, and the fundamental science developed to support this process could enable significantly improved cleanup of oil sands sites.

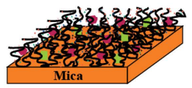
EXPECTED OUTCOMES

The outcomes will be a property database of the characterized bitumen and asphaltenes and working models of asphaltenes in organic solvents that will be used in non-aqueous oil sands extraction. We also aim to measure and correlate interaction forces in partially upgraded bitumen products to specific moieties, in collaboration with the research activities on hydrothermal partial upgrading of bitumen in T08-P02 and the Partial Upgrading Theme of FES.

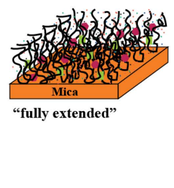


Asphaltenes in n-heptane





Asphaltenes in toluene



Asphaltenes in heptol

EXTERNAL PARTNERS

UAlberta has been working with **Imperial Oil** over the past 10 years to develop non-aqueous extraction (NAE) processes through the Institute for Oil Sands Innovation (IOSI). The NAE can operate at ambient temperature and generate dry stackable tailings, thus eliminate many of the challenging problems.

The research team at the university has been working with **Imperial Oil** on the properties and interaction behaviors of asphaltene and model compounds, non-aqueous extraction process research and development.

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