Selection of Flow Aids: Model-based Prediction of Flow Properties Enhancements]

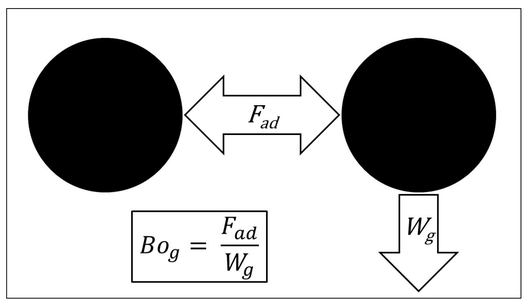
PI: Rajesh (Raj) Davé, New Jersey Institute of Technology
Graduate students: Siddharth Tripathi, Sangah Kim

Objective: Mechanistic prediction of flow properties and its enhancements from particle scale measures, developing a collection of models and decision tools that can be used for flow aid selection while minimizing the extent of experiments needed.

Recent Results: Review of existing particle adhesion models led to identification and addressing of main deficiencies, e.g., the effects of the particle surface roughness and the influence of nano-silica agglomeration. Key bulk properties of dozens of industry relevant fine powders were used to test applicability of the multi-asperity model with/without dry coating with varied amounts of hydrophobic or hydrophilic silica. Powder agglomeration identified as an indicator of powder flowability and dissolution.

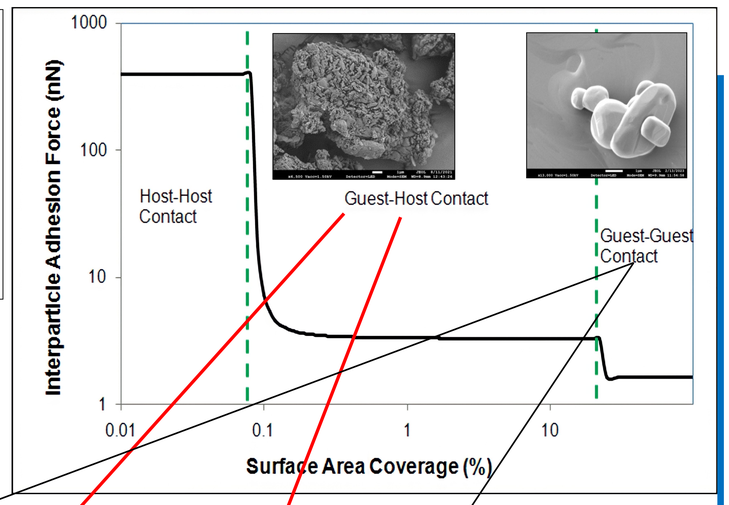
Multi-asperity Contact Models for Smooth and Rough Particles Accounting for Nano-coating

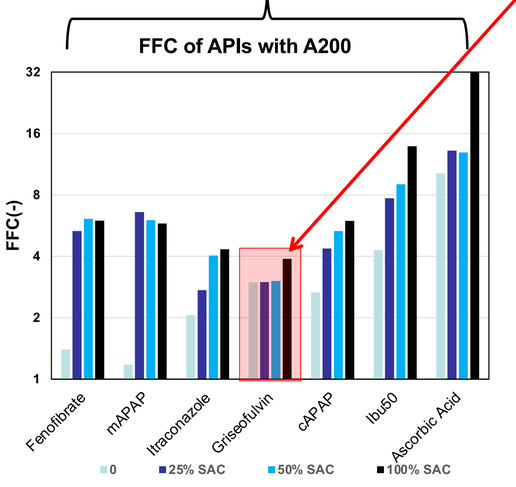
Model based SAC and wt% of nano silica to be coated

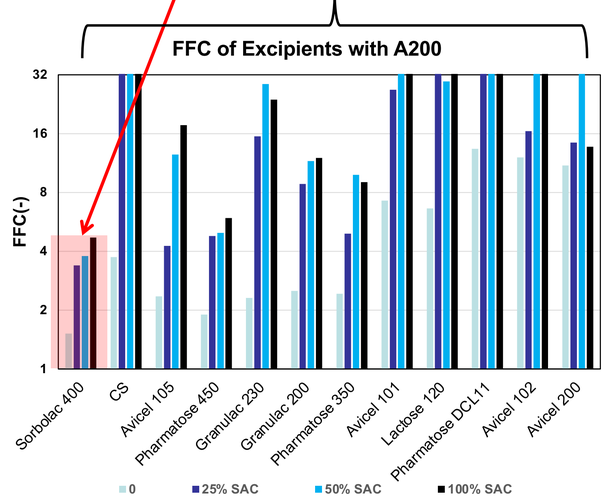


$$SAC = \frac{N \times \frac{\pi d^2}{4}}{4\pi\left(\frac{d+D}{d}\right)^2} \times 100\%$$

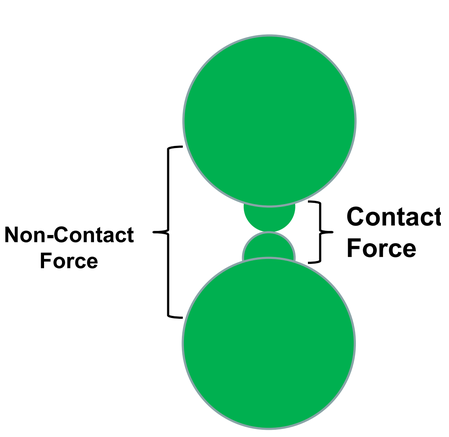
$$\text{Wt } \% = \frac{(Nd^3\rho_d)}{(D^3\rho_D) + (Nd^3\rho_d)} \times 100\%$$

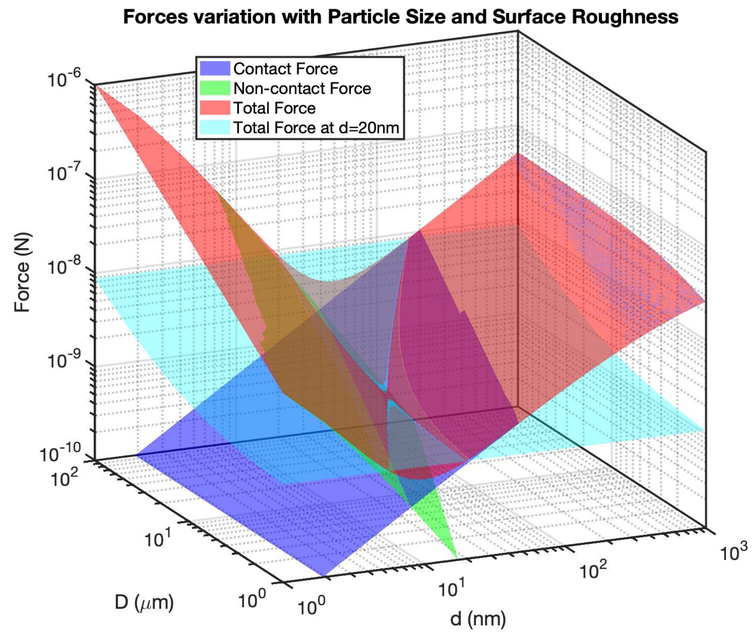




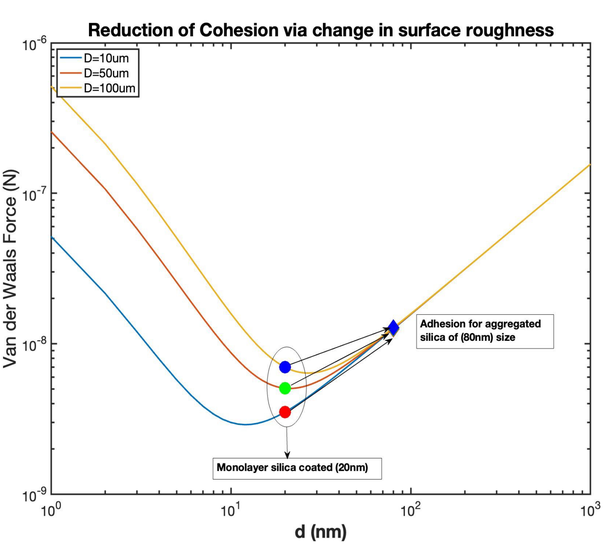


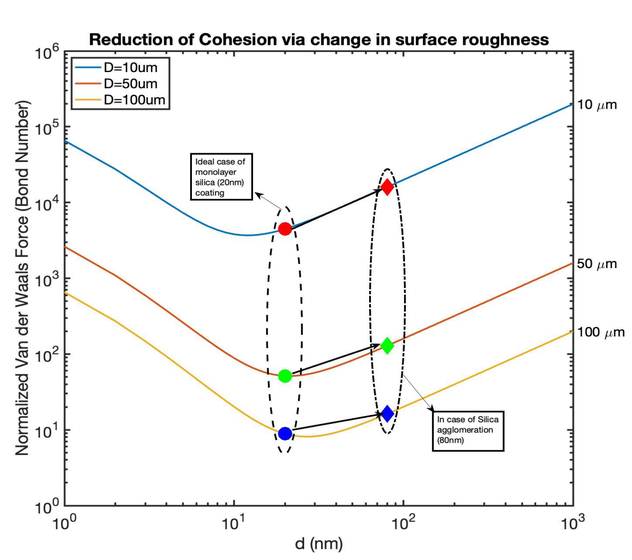
While surface area coverage-based weight percent estimation is recommended, macro rough powders often exhibit a contradictory behavior, deviating from the standard assumption of G-G contact above 30% SAC





Uncoated rough particles are less cohesive; difficult to enhance flow via dry coating; need more silica in part due to less effective coating

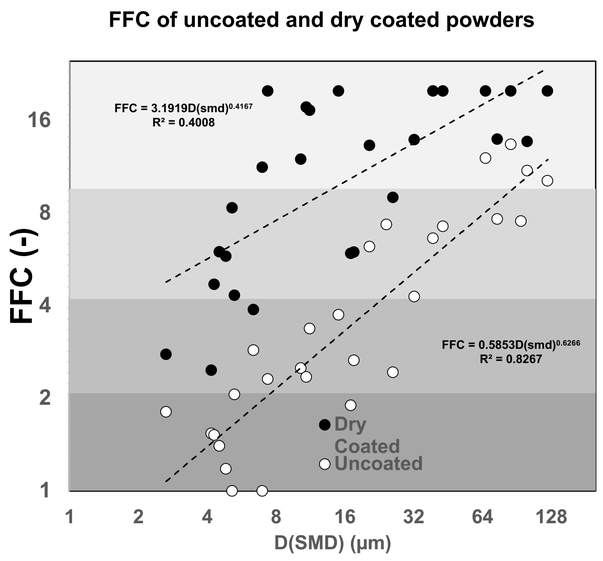


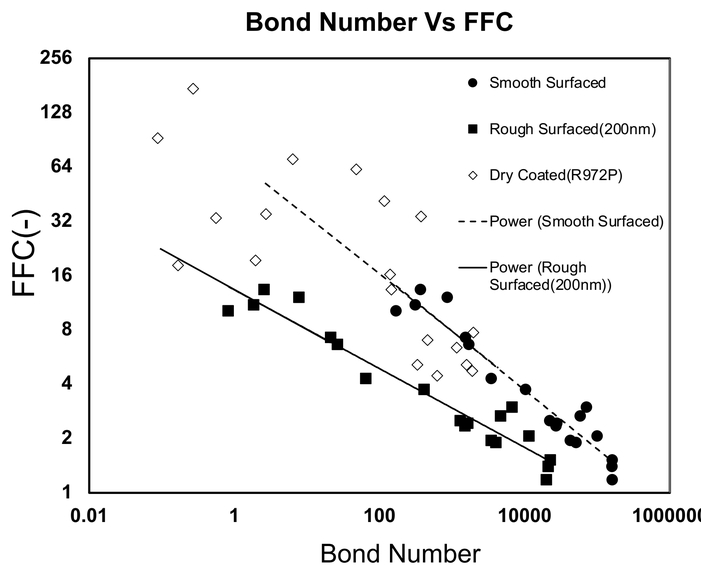


Silica Aggregation has adverse impact on dry coating performance

International Fine Particle Research Institute

Bond number to capture key parameters

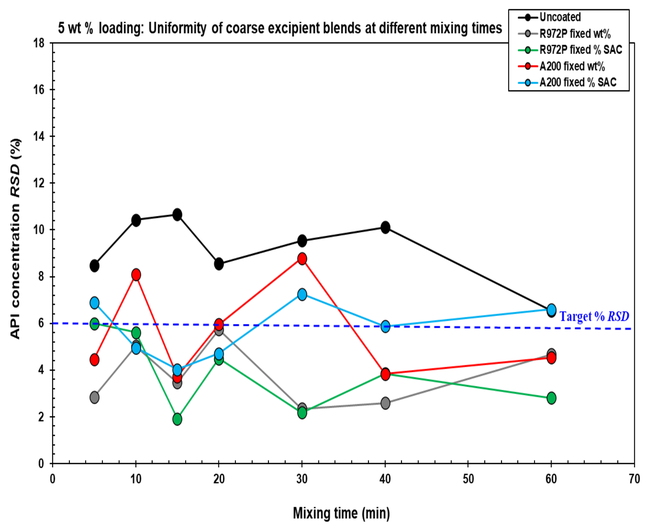


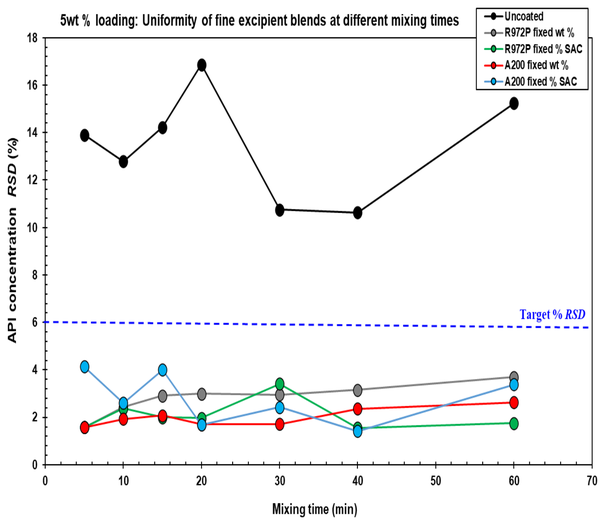


Particle size cannot capture

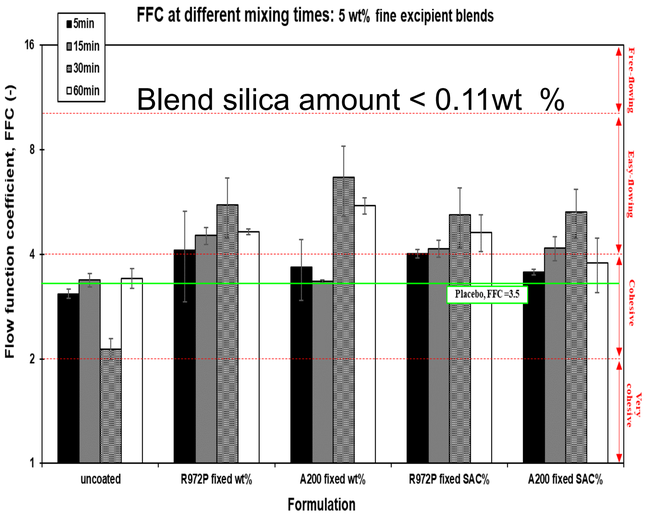
Most of the powders may not be **"naturally rough"**

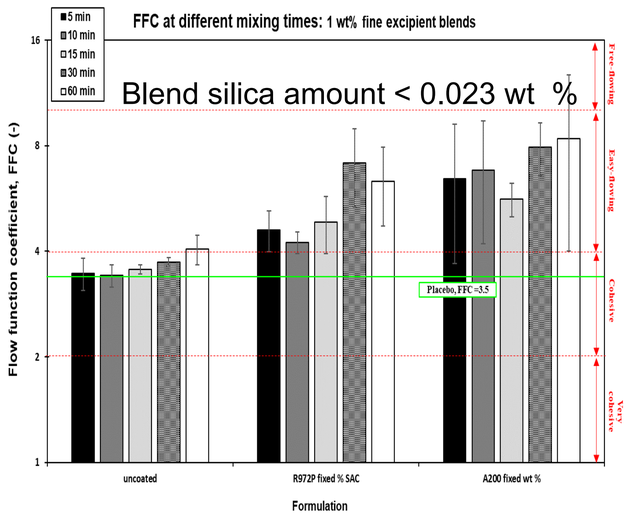
Blends with dry-coated constituent



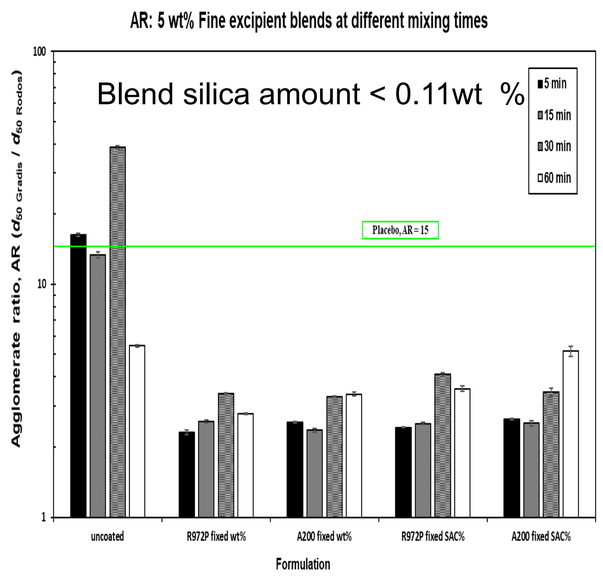


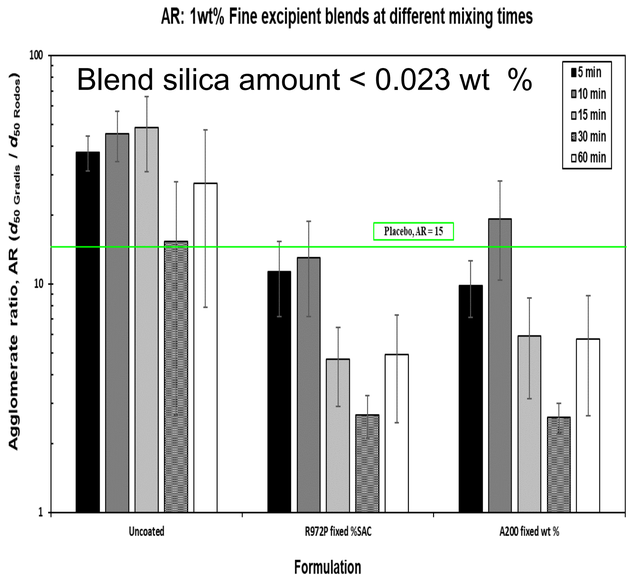
Enhanced fine powder blend uniformity attributed to synergy of silica transfer





Flowability of blends with a very low amount of a dry-coated constituent





Agglomeration of blends containing a very low amount of a dry-coated constituent (1 wt %): Examining the dynamics of mixing and silica transfer

Member input and collaborations are welcome!

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