

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

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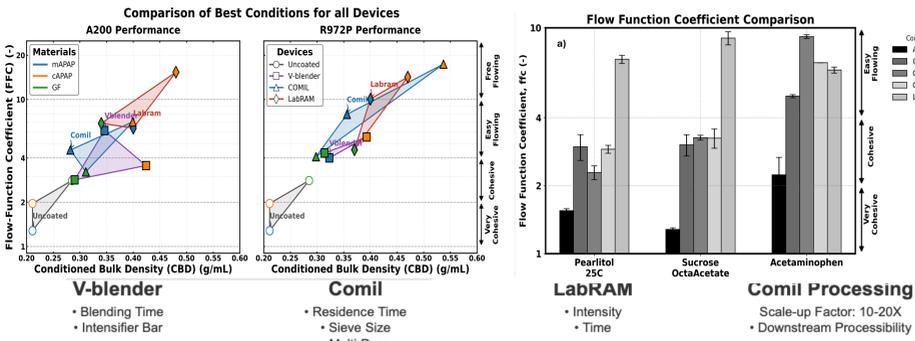
**Objective:** Develop and validate mechanistic models that predictively guide flow-aid processibility, including expected property improvements across various processes (batch vs. continuous), coating parameters (selection of flow aid type, amount, and processing intensity), device options (low vs. high shear), and resulting property improvements. Additionally, create practical tools to guide flow and processibility by translating the powder mechanics principles into enhancements in processibility.

**Recent Results:** Three mixing devices (V-blender, comil, and labRAM) with increasing intensity levels were tested on fine powders and flow aids. Higher intensity mixing produced better flowability and bulk density improvements. Lower intensity devices caused significant flow aid aggregation. The contact model was extended to account for cohesion reduction loss due to flow aid aggregation, incorporating fractal aggregate properties (particle count, porosity, size). Comil scalability was evaluated at the pilot scale. Dry coating significantly improved downstream feedability, tablet weight consistency, and overall tableting performance.

## Impact of Shear Intensity on Flow Aid Dispersion

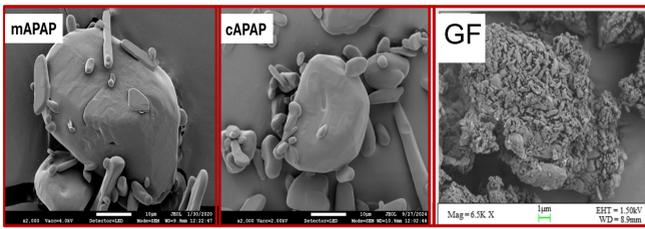
### Coating Device Performance

Low Intensity Batch Device | Medium Intensity Continuous Device | High Intensity Batch Device | Pilot Scale Comil (10-20X)



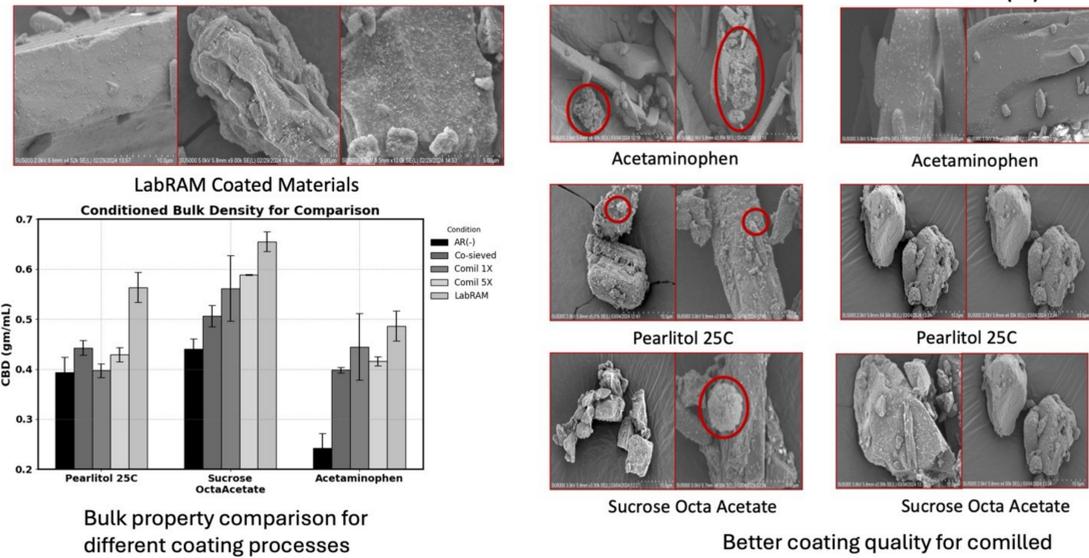
LabRAM generally best | Comil better when optimized | Vblender showed minimum improvements

Finding: Shear affects flow aid dispersion and deagglomeration, which affects final expected cohesion reduc



As received materials

## Device Scalability and downstream processibility improvement

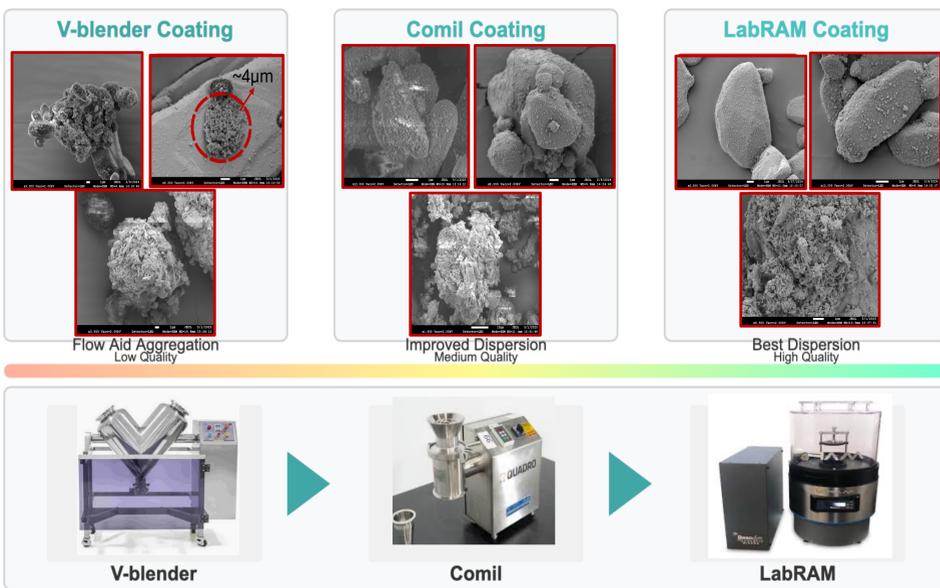


Bulk property comparison for different coating processes

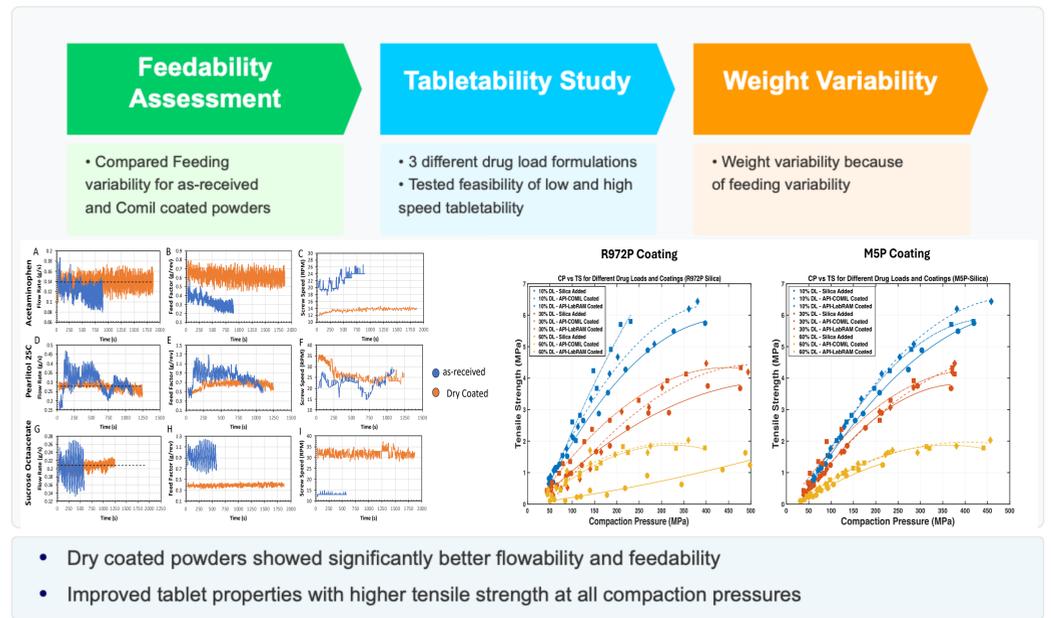
Better coating quality for comilled

- Comilled samples bulk property improvement across all samples
- Property improvement with 10-20X scale up using pilot scale comil
- SEM images confirm better coating quality in comilled samples compared to co-sieved
- Improved downstream processibility demonstrated at pilot scale (10-20X)

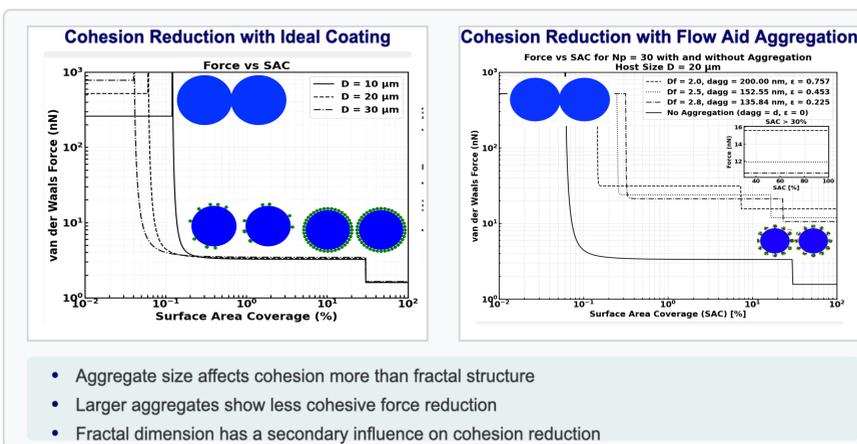
## Coating Quality Comparison



## Processibility Improvements using Flow Aid Coating



## Modeling Cohesion Reduction for Flow Aid Aggregation



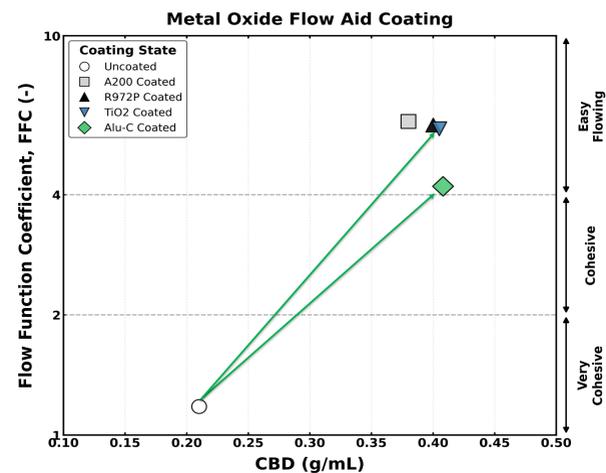
- Aggregate size affects cohesion more than fractal structure
- Larger aggregates show less cohesive force reduction
- Fractal dimension has a secondary influence on cohesion reduction

### Mechanistic Model for Flow Aid Aggregation

Prediction of cohesion reduction as a function of aggregate size, porosity, and fractal dimension

Metal Oxide Properties	Size(d)	Density (kg/m <sup>3</sup> )	vd (J/m <sup>2</sup> )
A200	12nm	2200	42.8
R972P	20nm	2200	36.4
Alu-c	13nm	2710	63.39
TiO2 (P25)	24nm	4230	14.66

Metal Oxide based flow aids



### Current and Future Activities

- Flow aids beyond Silica:
  - Other metal Oxide-based nano-particles
- Mixing synergy for flow-aid coated material with uncoated components in a blend
- Integrated model for use by IFPRI members