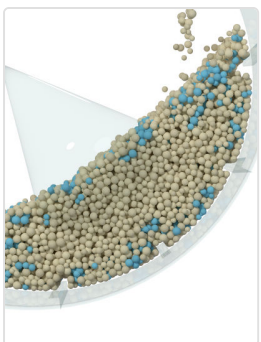
MULTI-SCALE · MULTI-PHYSICS · ONE CODE

TabletSimAI: from granulation to the coated tablet, one digital twin.

Not a single simulation. The whole process, from binder spray granulation to a coated tablet, coupled across scales and physics in one code, each step handing its state to the next.

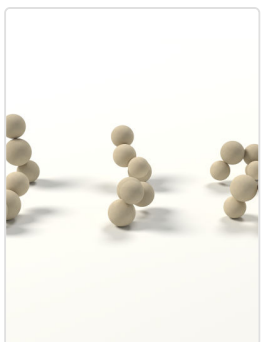


1 Granulation

MOLECULAR

Molecular forces bind the granules

granules as clumps or polyhedra



2 Granule shapes

GRANULE

Shapes extracted from the run, not sampled

into the blend

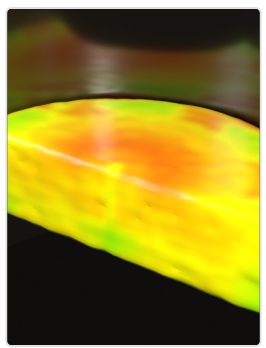


3 Mixer

GRANULES AND FINES, REALISTIC SIZE RATIO

DEM with cohesion laws

dose cut, DEM to SPH



4 Die compaction

POWDER CONTINUUM

Powder SPH holds density and stress

SPH to elements

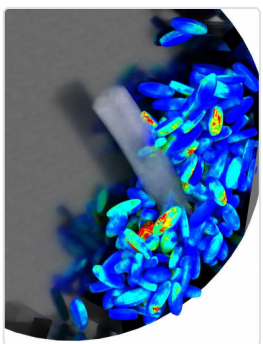


5 Tablet

SOLID

Bonded polyhedral elements with the compact's stress and porosity

bonded tablet into later processes



6 Coating

COATED TABLET

Bonded tablet, SPH spray

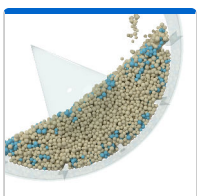
MOLECULE → COATED TABLET

Each material is calibrated once, never per simulation. After that the particle properties stay fixed, so a process change at any step can be followed through to the strength of the final tablet.

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The chain, from granulation to coating

The chain starts with the binder spray granulation. Tablet strength depends on how the blend fills the die, and each step hands its state to the next: the mass, lubricant and glidant are carried from the cut to the tablet.



Granulation

Binder spray forms the agglomerates.



Granule shapes

Agglomerates as clumps or polyhedra.



Mixer blend

Granules and fines as particles at a realistic size ratio, with lubricant and glidant.



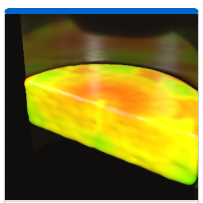
Dose cut

Cut from the blend, whole clumps kept.



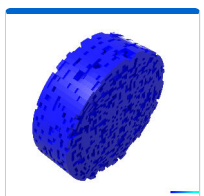
Die fill

The dose settled in the die.



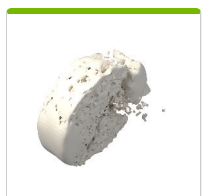
Compaction

Density and stress in the powder.



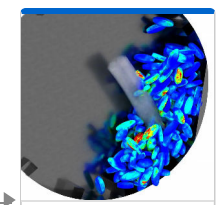
Tablet

Bonded solid with the compact's porosity.



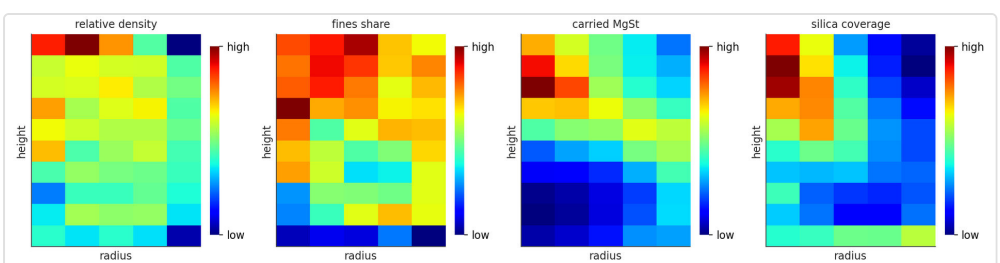
Tests

Strength test and ejection.

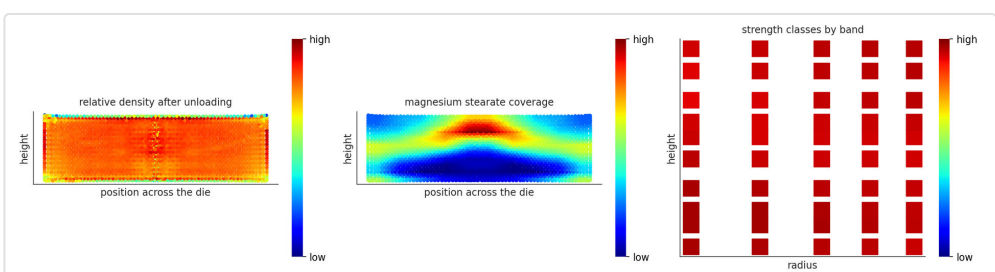


Coating

Bonded tablets in a drum under an SPH spray.



Handed over from the die fill: density, fines share and carried lubricant and glidant through the fill.

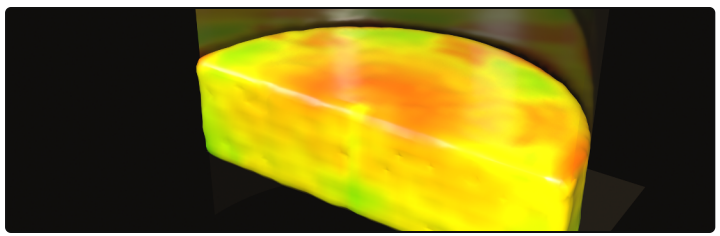


In the compact: the density varies as in the fill; lubricant coverage per band can map onto strength classes.

Die compaction, then the tablet

The powder is pressed as a continuum for the density and stress field in the die. The compact becomes a tablet of bonded solid elements that leaves the die intact and breaks in the strength test.

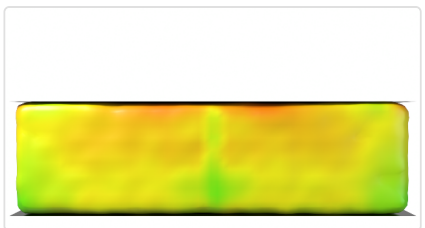
DIE COMPACTION: STRESS IN THE POWDER, LOW (BLUE) TO HIGH (RED), ONE SCALE



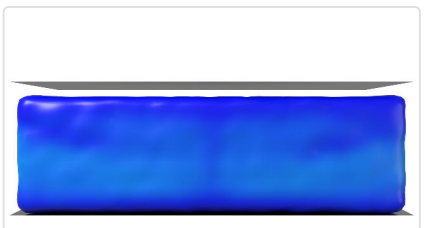
Cut open at peak load



Start

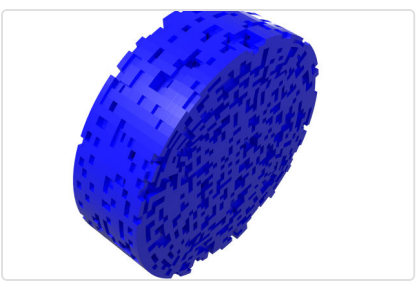


Peak load

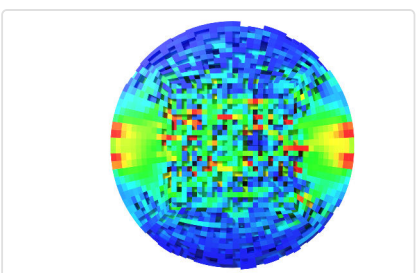


After unloading

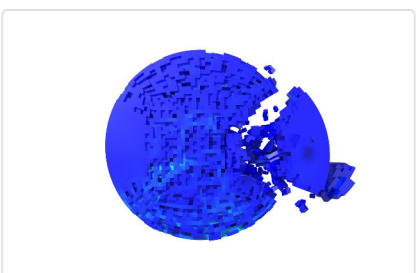
THE TABLET: EJECTION, THEN THE STRENGTH TEST



Ejected from the die, intact

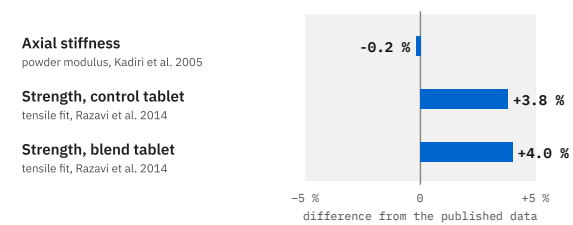


Strength test, at the peak



After the split

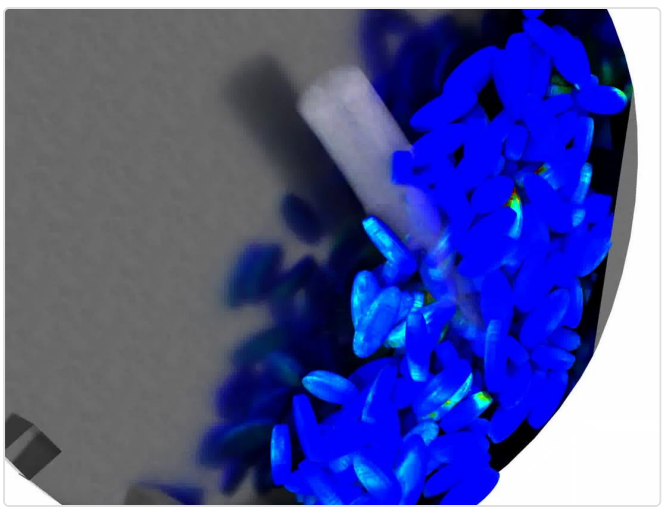
Against published data for MCC tablets



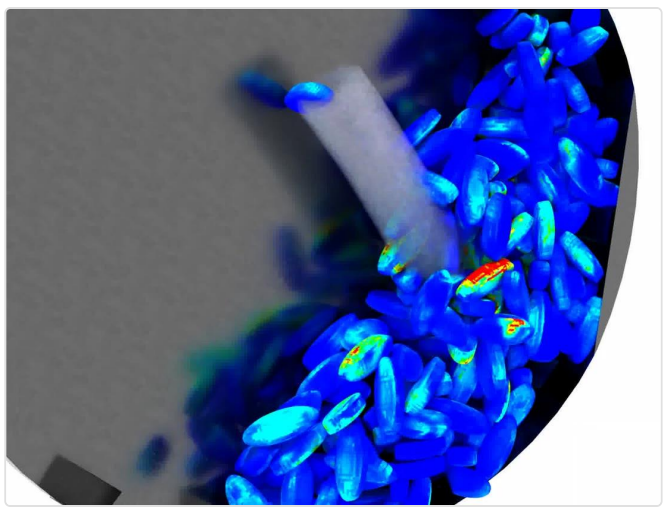
Coating: the tablet in a later process

A bonded tablet can be put into any later process and evaluated there. Here caplet shaped Element tablets tumble in a baffled drum under an SPH spray, and the coating collected on each tablet surface is tracked.

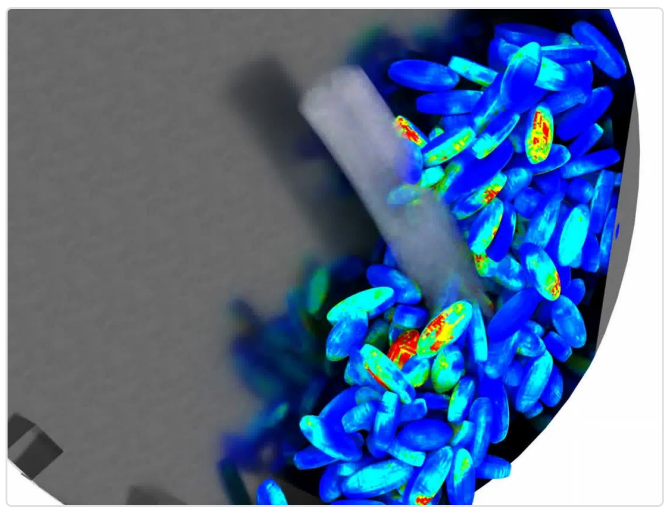
TABLETS COLOURED BY THE COATING COLLECTED ON EACH, LOW (BLUE) TO HIGH (RED), ONE SCALE



Spray start



Part way



Late in the run

The spread of coating between the tablets can be seen as they tumble through the spray. The demonstration uses caplet shaped tablets, a different shape from the disc tablet of the chain.

TabletSimAI: a model that learns the whole chain

Because every step runs in one code with fixed material properties, the chain runs become training data. The model links a setting at any step to the strength of the final tablet.

1 **Settings at every step**

Granulation: binder and drum. Mixer: time, lubricant, glidant. Die fill: dose and fill pattern. Compaction: punch force and speed. Coating: spray and drum speed.

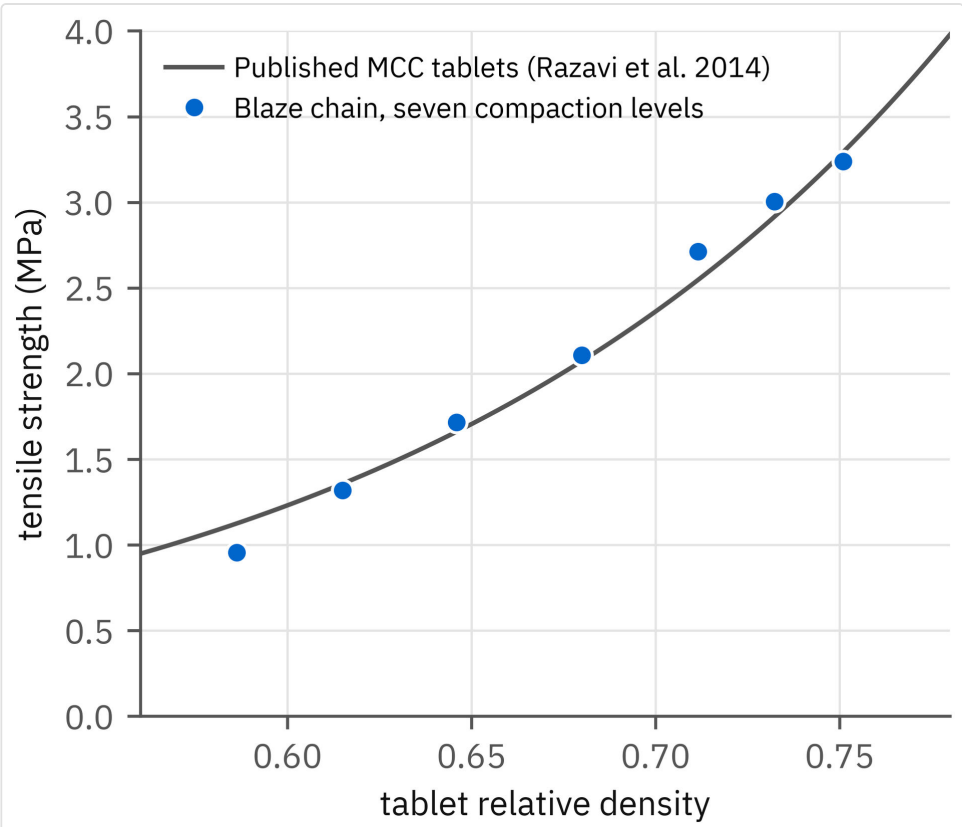
2 **Blaze chain runs**

Granulation, mixer, die fill, compaction and tablet in one code, with the bonded tablet available for coating. Each run hands its state to the next step, so every run is a complete record from setting to tablet.

3 **TabletSimAI**

Trained on the chain runs. Predicts tablet strength with its uncertainty, and names the next runs that teach it most.

Ask what a process change does to the tablet before the press trial, from a model that knows the physics of every step.



Runs it learns from: strength at seven compaction levels, no refitting, against published MCC data.