

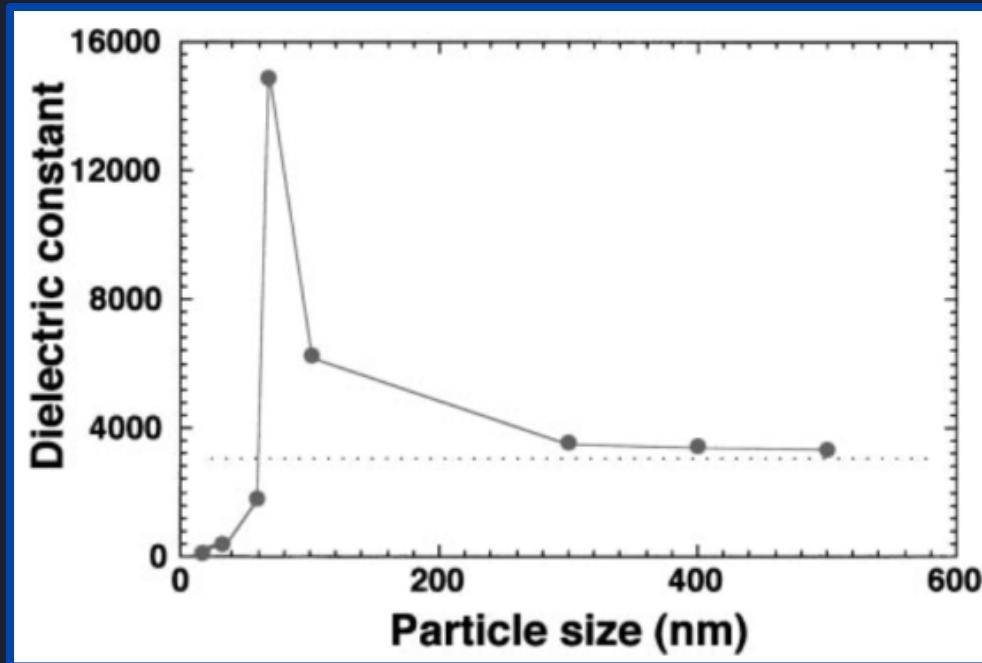
Measuring the Permittivity of Ferroelectric Nanoparticles in an Epoxy Composite

[Presenter name(s), credit collaborators]

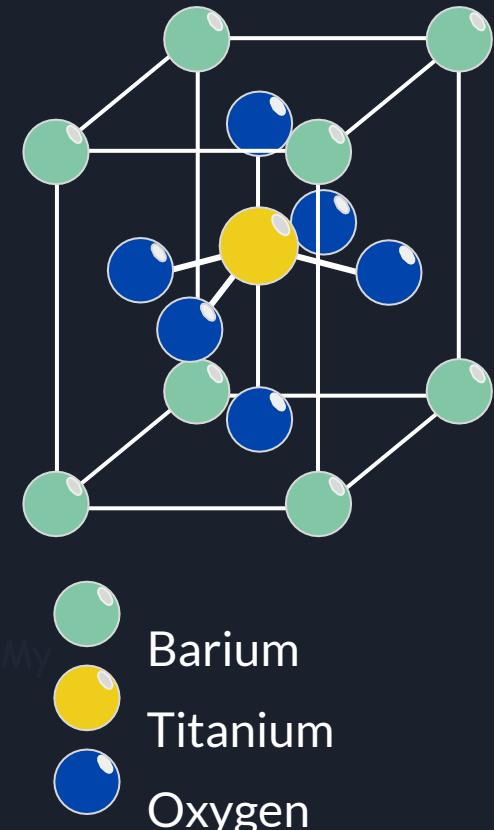
Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

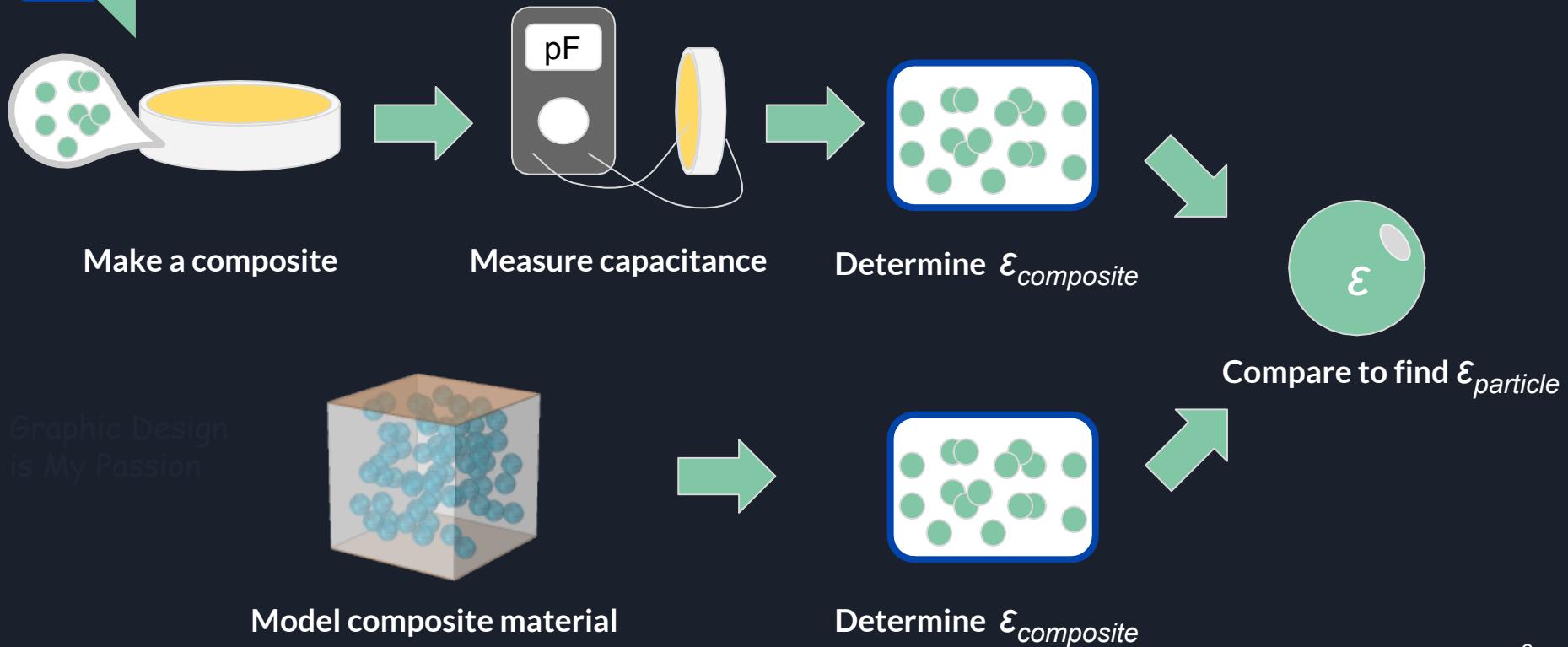
$$\epsilon_{BTO}(r) = ?$$



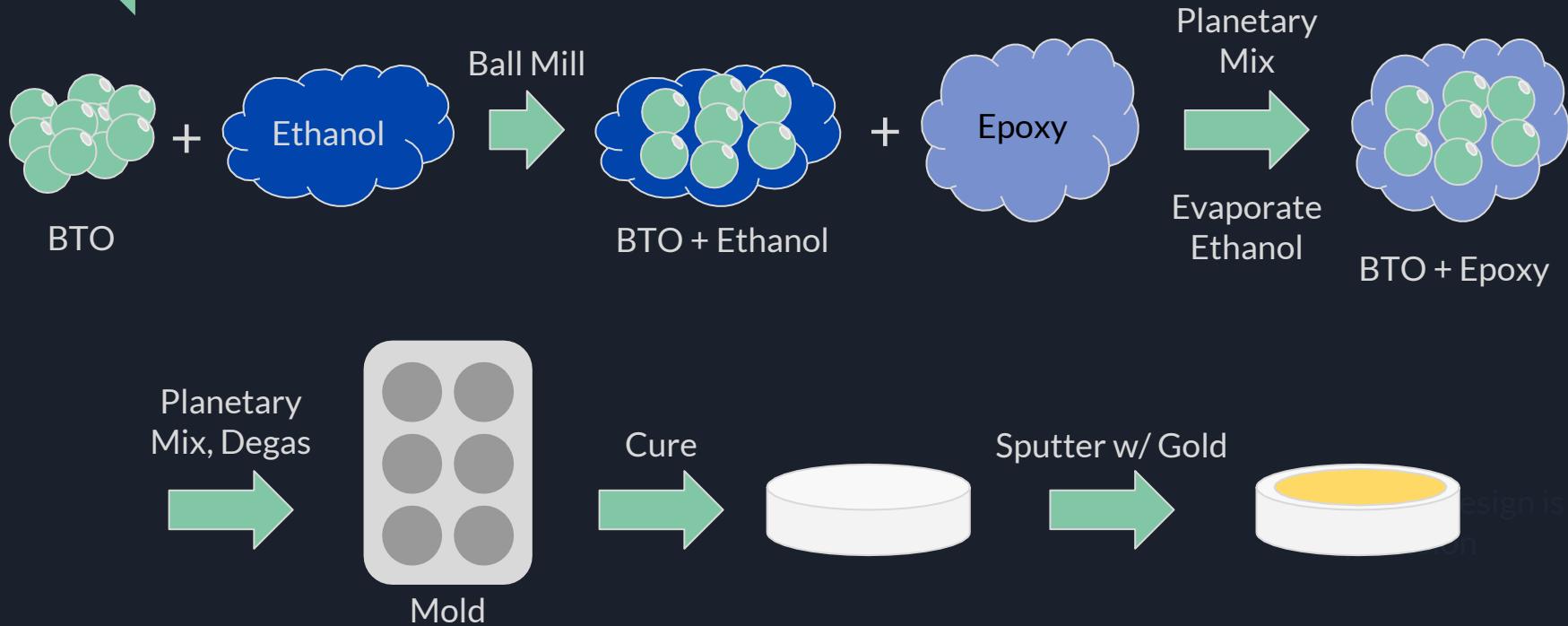
Satoshi Wada et al 2003 Jpn. J. Appl. Phys. 42 6188



The Plan

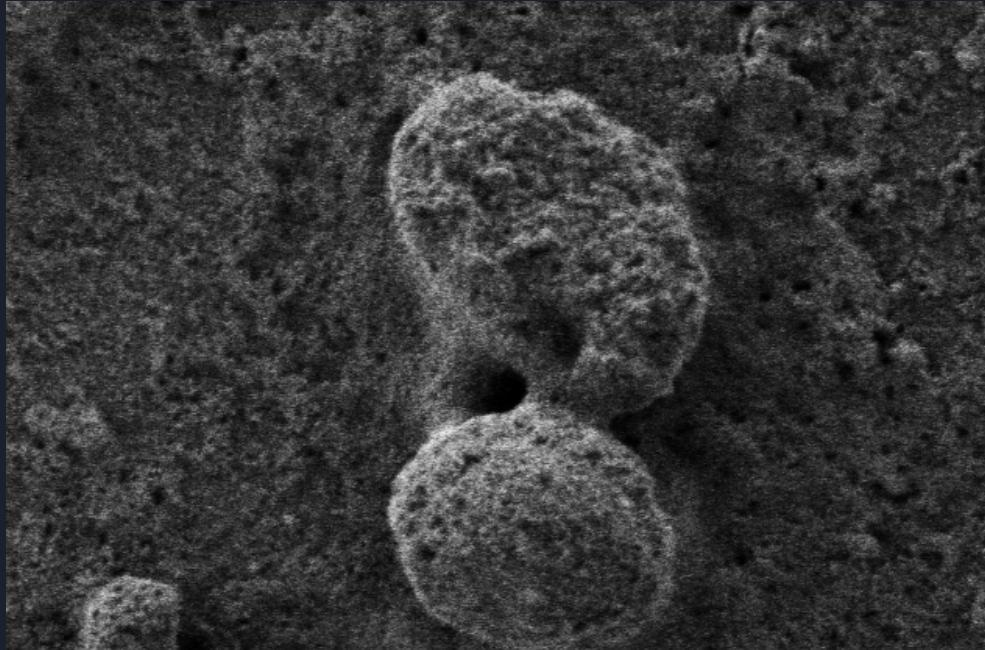


Preparing Composite Sample



Particles as Received

Donated by
Sakai Chemical



500 μm

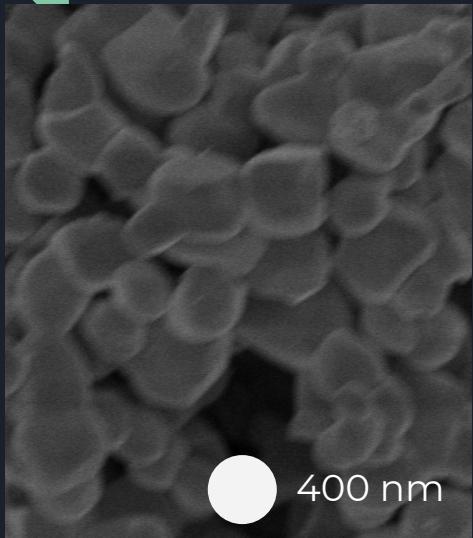


Ball Mill Breaks Agglomerates

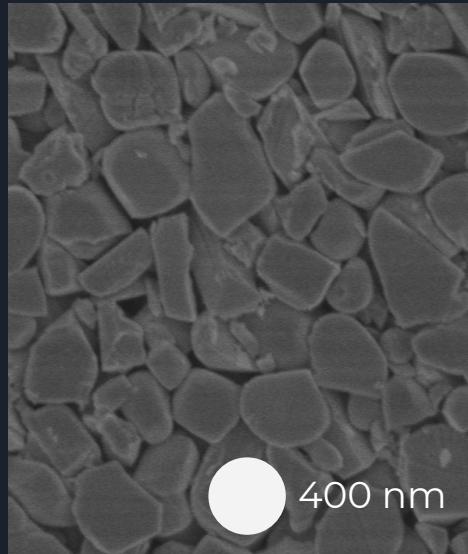
Detsch Grinding Ball Movements



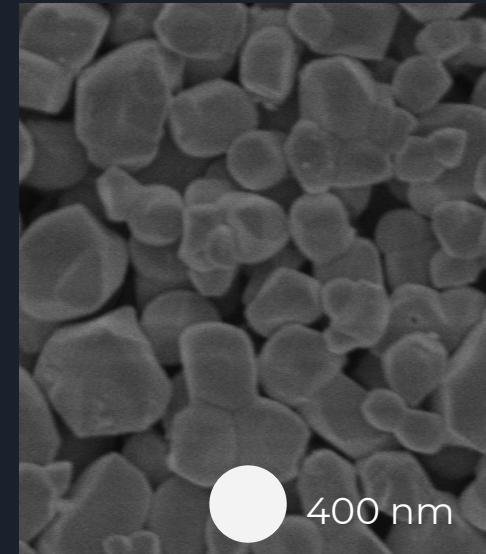
Before and After Ball Milling



As received



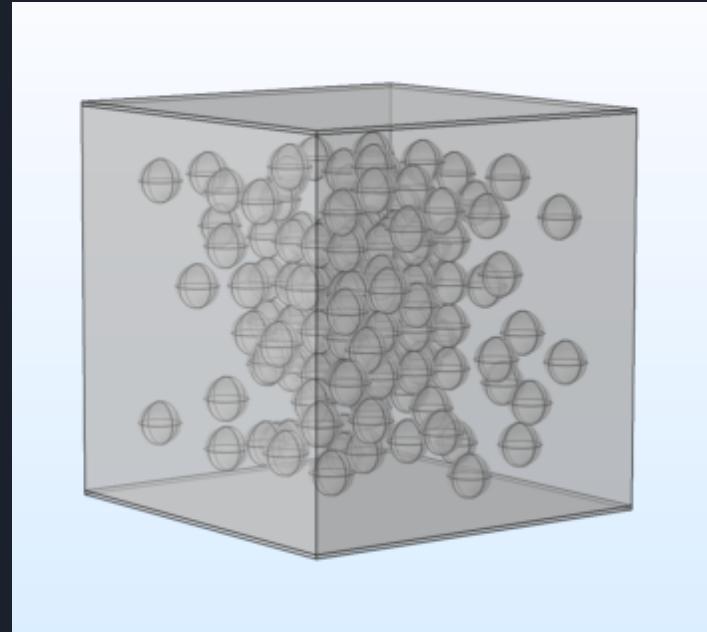
300 RPM
75 minutes



150 RPM
90 minutes



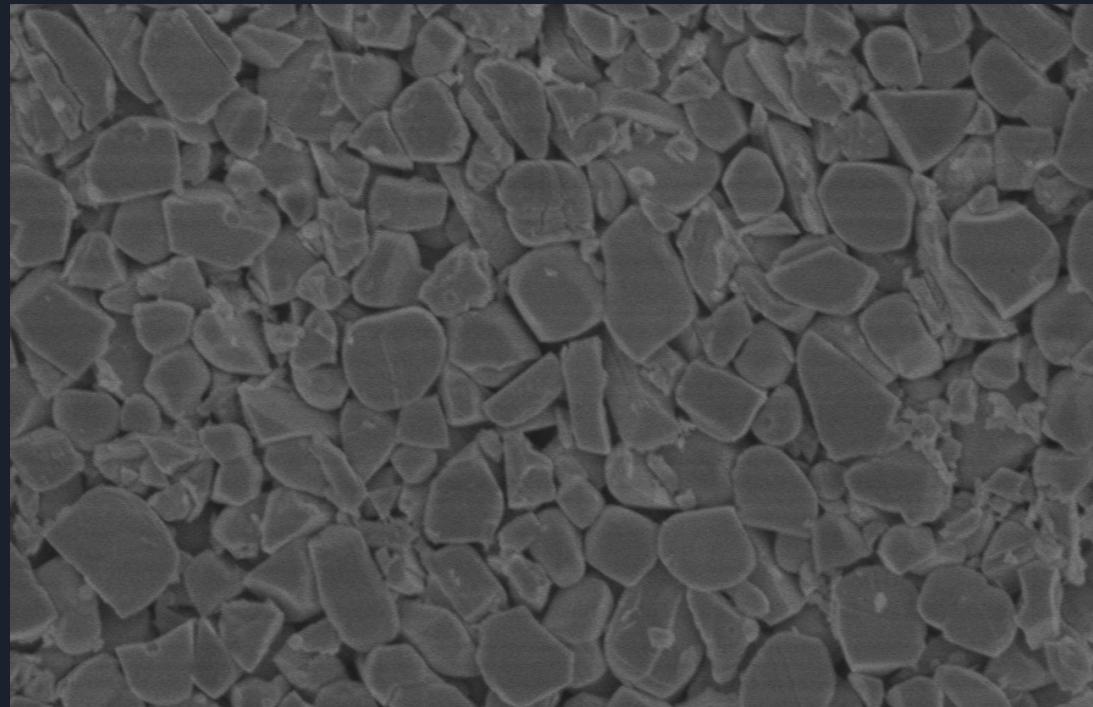
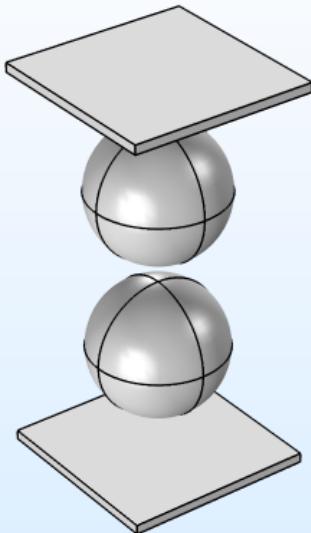
Modeling BTO Composites



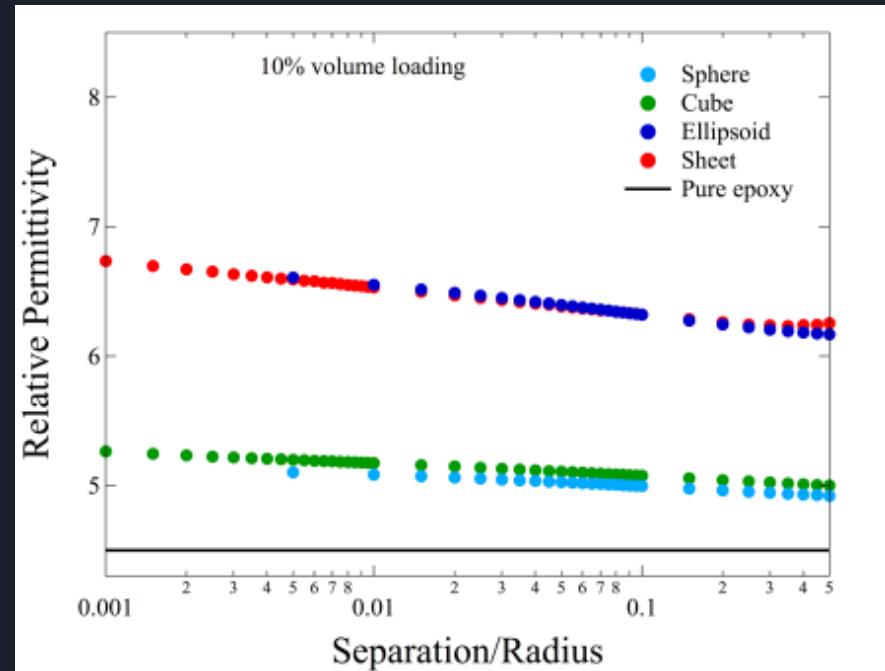
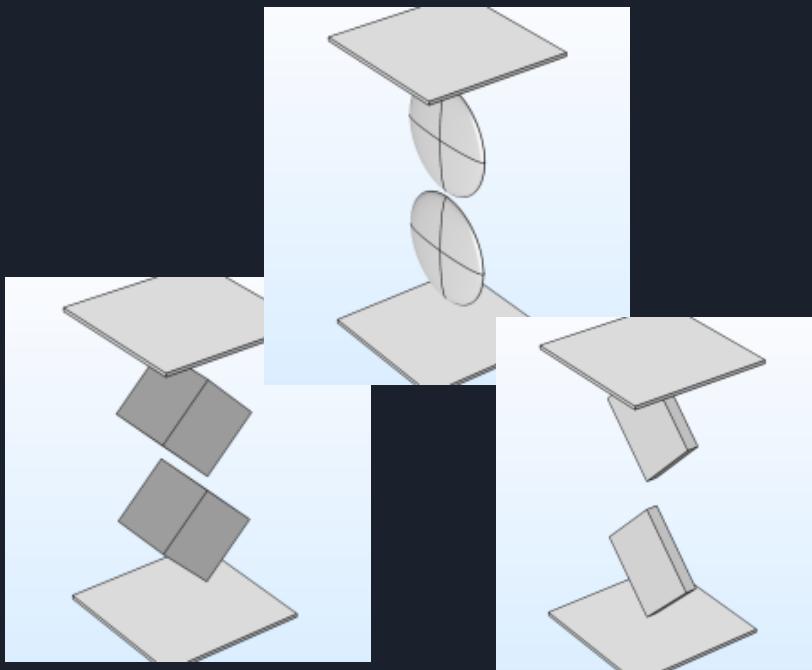
- Vary degree of agglomeration and number of dispersed particles
- Attempt to match measured dielectric constant



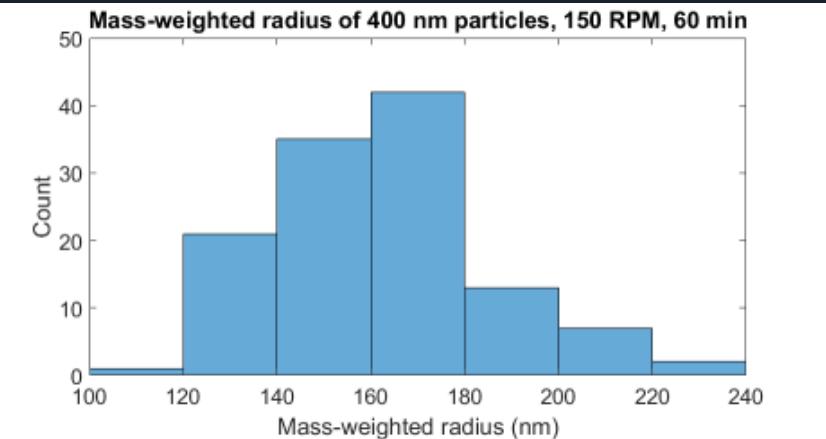
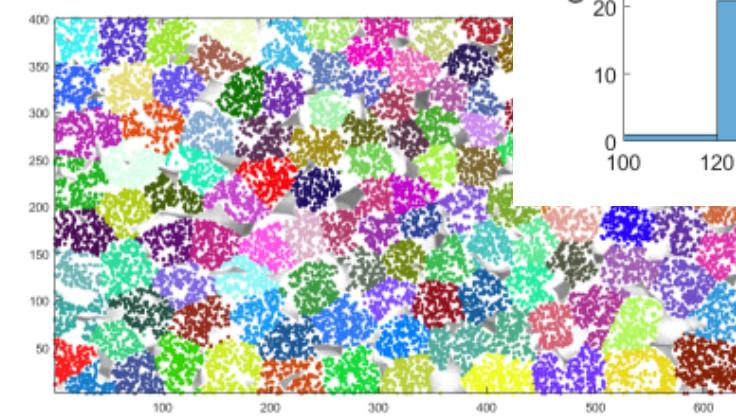
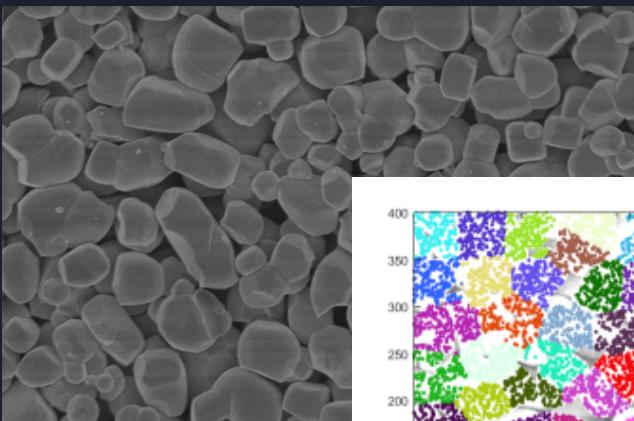
Two Particle Model



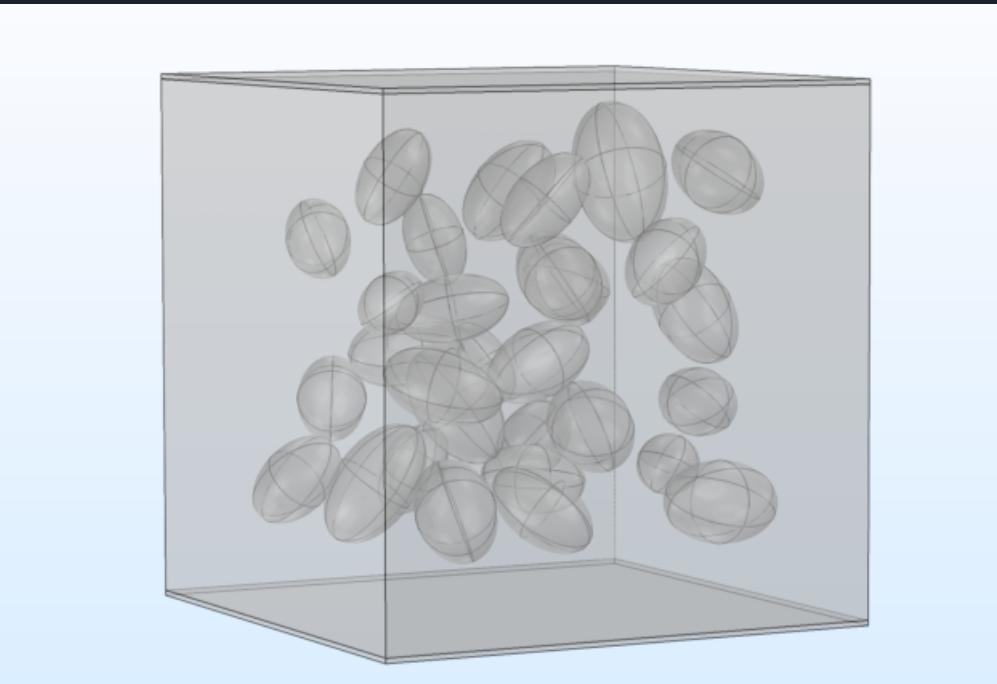
Relative Dimensions Matter More Than Edges



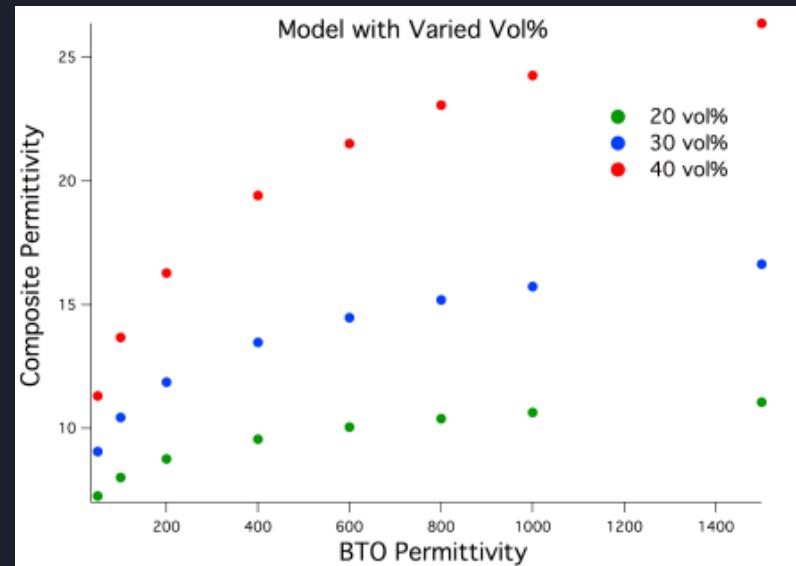
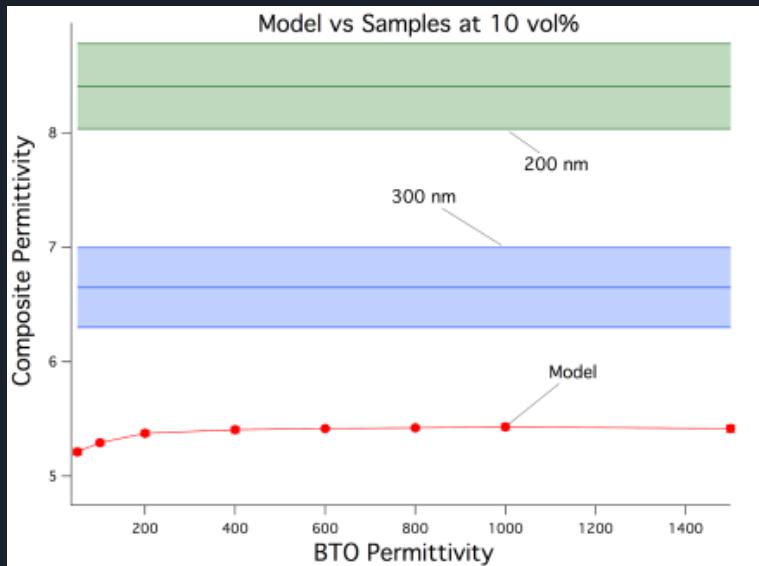
Extracting Radii From SEM



Implementing Randomized Ellipsoids



Model Currently Not Sensitive to Measured Values





Data so far

- 2016-17 samples
- Matched to simulation

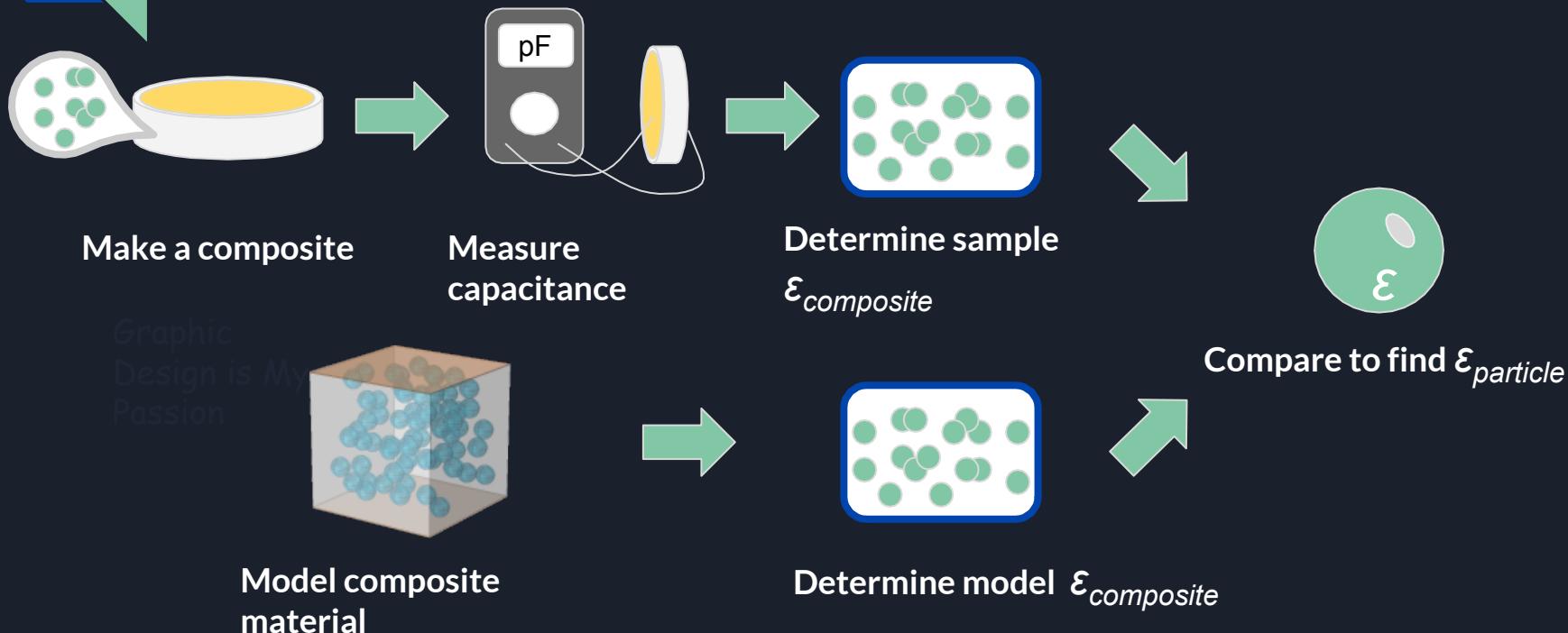
	100 nm	200 nm	300 nm	400 nm	500 nm
10 vol%		7.4 +/- 0.1	7.0 +/- 0.1		6.8 +/- 0.1
20 vol%		10.4 +/- 0.1			8.0 +/- 0.1



Future work

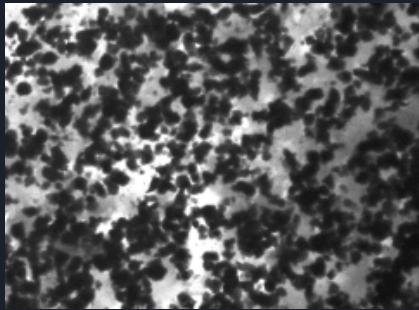
- Manufacture higher vol% samples
- Improve dispersion during manufacturing
- Limit damage to particles during ball milling
- Extract particle dimensions from SEM images
- Implement particle geometries in full model

Questions?



Special thanks: Prof. Van Ryswyk, Prof. Haskell, Dr. Todd Monson, Logan Rubin, and David Vargas

Reconstructing Samples



Original TEM

1 μm



Final Reconstruction

