Catalyst Layer Characterization: *Prior methods*

**TEM images**
- 2 µm
- Raw
- Segmented

**3D reconstruction with FIB-SEM**
- Ziegler et al., *J. Power Sources* 196 pg. 2094 (2011)

**Pros & Cons**

**TEM images**
- **pro** High resolution
- **con** 2D integral slice image (no 3D)
  - Hard to distinguish ionomer vs. pore

**3D reconstruction with FIB-SEM**
- **pro** High resolution
- **con** Destructive to sample
  - Vacuum environment
50 nm Resolution X-ray CT

- Same fundamental technology as medical CT scans – 3D images
- Non-destructive
- No vacuum required
- Lower in-plane resolution than SEM or TEM
- With optics, 50 nm 3D resolution (32.5 nm voxels)

Use nano-CT to image electrode in 3D
PEM Fuel Cell Electrode: Nano-CT

Challenge: Nafion swell during imaging

Solution: Sample mounted on Kapton

Results validated by:
- Mercury intrusion porosimetry
- Transmission electron microscopy

Size Distributions

Solid

Pore


E1 Avg. $D \approx 190$ nm
Size distribution: Effect on agglomerate model

- Agglomerate model predicts fuel cell performance\(^1\)
- Incorporate distribution of agglomerate sizes, instead of single, representative spherical agglomerate size\(^2\)

Result:

Higher current

Greater contribution from smaller agglomerates

Smaller representative agglomerate size

Result: