

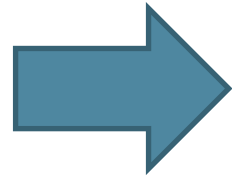
Quality Control in PEM Electrolyzers

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US DOE, NRC Canada, Fraunhofer ISE



47+ years PEM electrolyzers



World's largest user of LH2

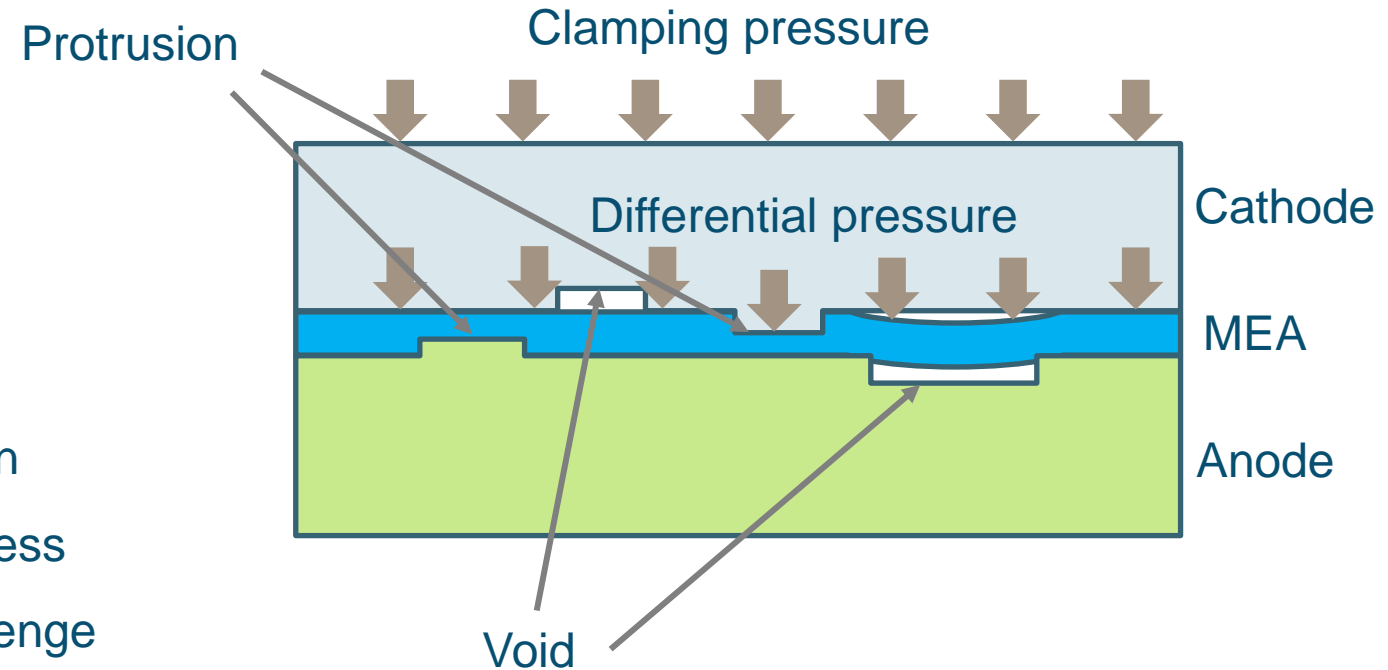
- 129 repeat cells
- >1000 cm² active area
- Cell potentials ~2V
- 40 bar differential pressure



1MW Allagash PEM electrolysis stack

- High differential pressure:
 - Higher sensitivity to pinhole defects
 - Higher sensitivity to membrane thickness variations
 - Higher sensitivity to defects in PTLs (esp. anode)
- High water flowrate
 - Lower sensitivity to hotspot-inducing defects
- Higher cell potentials:
 - More expensive anode flow field materials
- Higher demand
 - >50GW pipeline under development
 - Global commitments >500 GW by 2050

- Areas of interest:
 - Protrusions: cathode and anode
 - Voids: anode only
- Potential consequences:
 - Catalyst layer shearing
 - Membrane shearing & pinhole formation
- Critical length scale: $\sim(O)$ membrane thickness
 - Thinner membranes pose greater challenge
 - Exacerbated by membrane thinning at EOL
 - Low-cost PTL materials expected to be more challenging

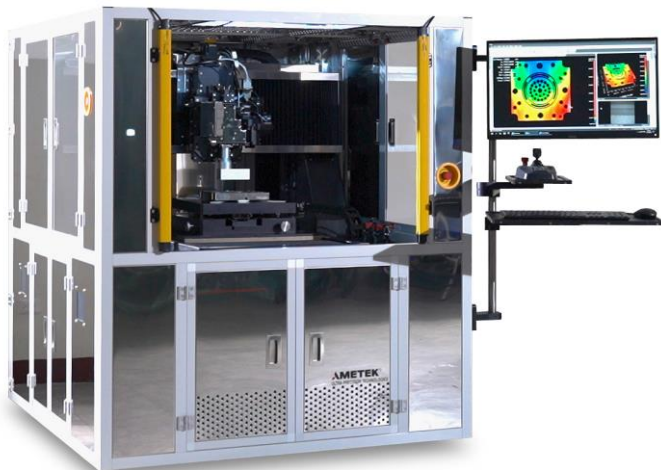


- Resolution:
 - Z: +/- 1-5% membrane thickness
 - XY: +/- 5-10% membrane thickness
- Scan rate: 1GW/yr. = $\sim(O) 10^2 - 10^3 \text{ cm}^2/\text{min}$



- Continuous on-line inspection:
 - Scan width: ~50 cm
 - Scan rate: (O) cm/sec
- Discrete part inspection:
 - Scan area: >1000 cm²
 - Scan time: (O) minutes / part

Sampling of existing 3D diagnostics



Coherence scanning interferometry
600 mm x 600 mm
Resolution: <math><0.1\mu\text{m}</math>
Scan rate: (O) $10\text{ cm}^2/\text{min}$



Structured light displacement
200mm x 300 mm
Resolution: $5\mu\text{m}$
Scan rate: (O) $10^2\text{ cm}^2/\text{min}$



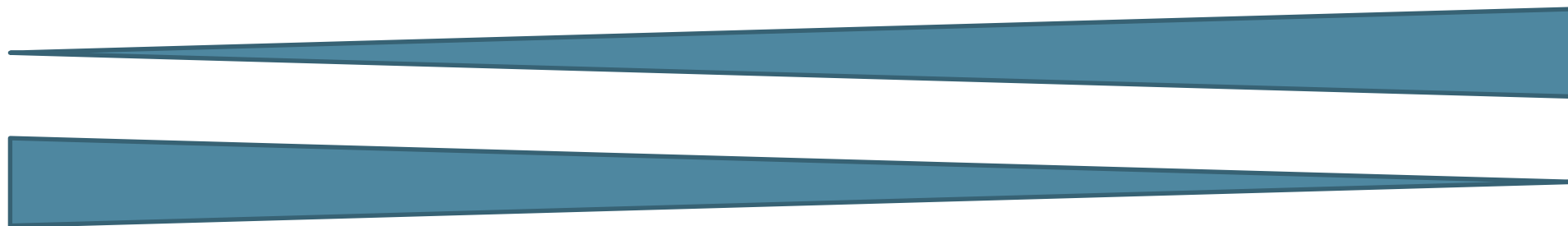
Scanning laser displacement
>30mm width
Resolution: $5\mu\text{m}$
Scan rate: (O) $10^2\text{ cm}^2/\text{min}$



Photogrammetry
> 600 mm x 600 mm
Resolution: $100\mu\text{m}$
Scan rate: (O) $10^3\text{ cm}^2/\text{min}$

Scan rate

Resolution





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