Microstructure effects on leakage in cryogenic hydrogen storage

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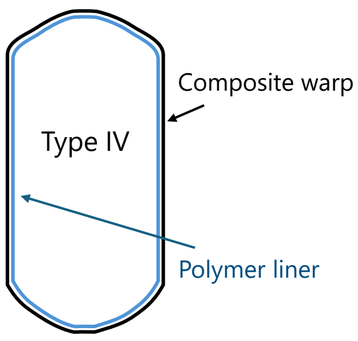
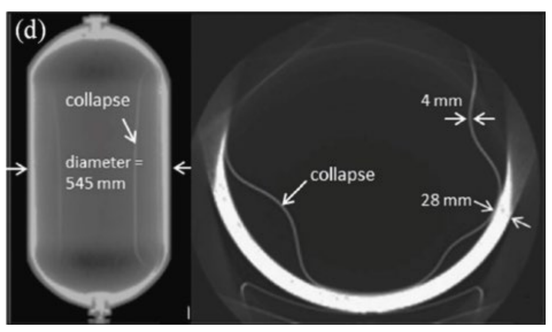
BACKGROUND

- Limitation in Type IV vessels: manufacturing challenges, hard to recycle, prone to failure

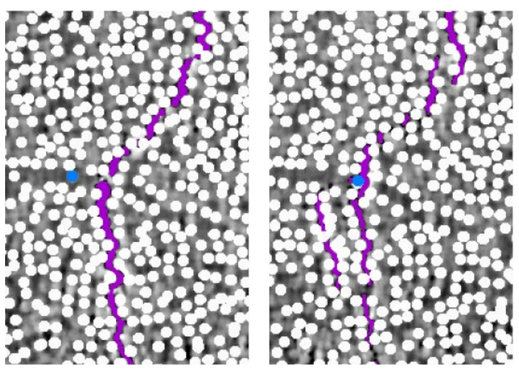




Yan, Y., et al. *Renewable and Sustainable Energy Reviews* 189 (2024): 114009.

HOW?

➢ Single-fiber misalignment causes the crack path branching



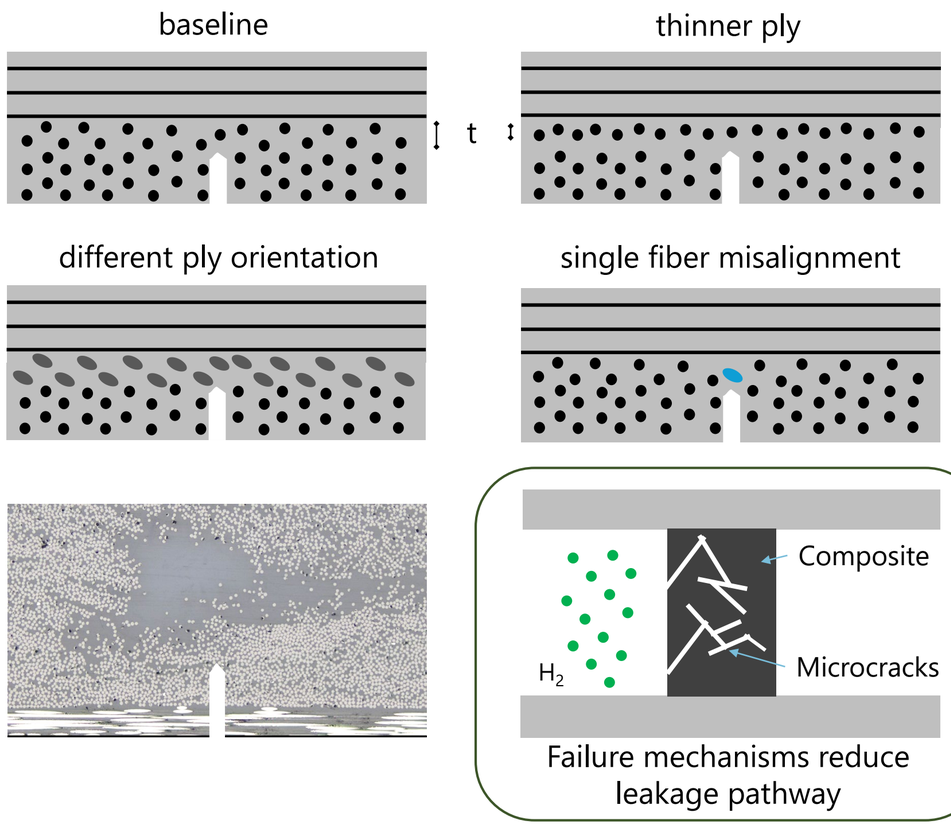
X-ray CT scan
Slice difference: 80 um

Purple: crack path

Blue: single-misalignment fiber

Hosseini, S., Atli-Veltin, B., Ji, Y., and Dransfeld, C. ECSSMET 1 (2023): 1-9.

➢ Experimental investigations on crack propagation under various microstructures of CF/LMPAEK laminates

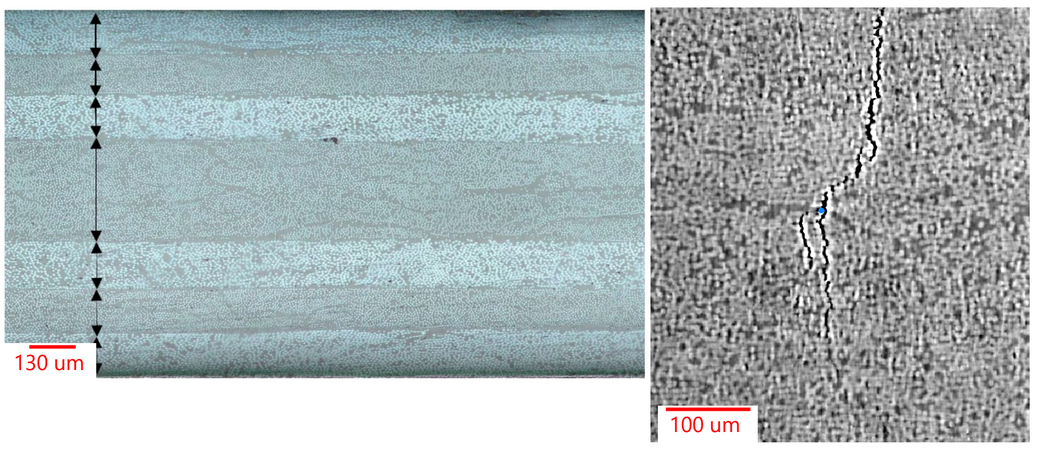


OBJECTIVE(S)

- Tailored thermoplastic composites to control crack growth within the Type V full composite vessels
- Understand microstructure effects on crack formation in cryogenic hydrogen storage applications

WHY?

- Linerless Type V vessels: composite acts as both the **gas barrier** and **load bearing structure**
- For CF/LMPAEK composites, micro-cracking is the major cause for the hydrogen leakage



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Complex crack network

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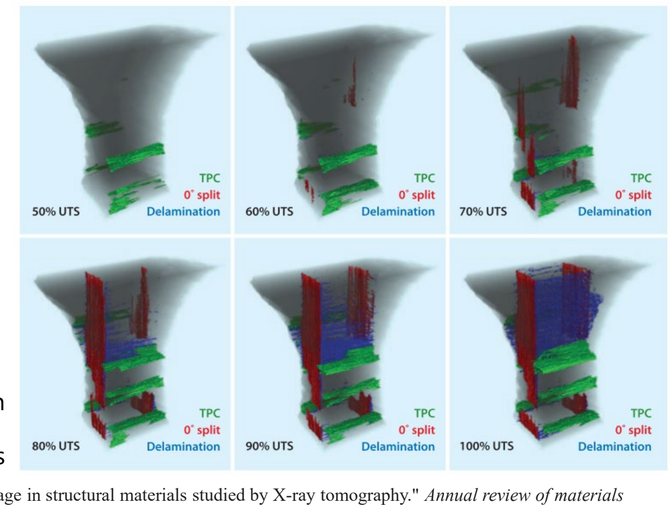
Leakage path for hydrogen



UTS: ultimate tensile strength

TPC: transverse ply cracks

Withers, Philip J., et al. "Fatigue and damage in structural materials studied by X-ray tomography." *Annual review of materials research* 42.1 (2012): 81-103.

RESULTS

- Understand the crack path deflection/branching affected by CF/LMPAEK microstructures
- Design the failure mechanisms to delay the through-thickness crack path formation

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