Contribution ID: **81** Type: **Oral Presentation**

Diffusion properties of the gas diffusion layer from three dimensional digital images of the fibrous substrate and the microporous layer

Wednesday, 24 May 2023 09:30 (15 minutes)

Direct numerical simulations are performed on reconstructed two-scale three-dimensional digital images in order to compute the effective diffusion properties of a gas diffusion layer (GDL) made of the assembly of a fibrous gas diffusion medium (GDM) and a microporous layer (MPL). The two-scale digital images are obtained by using micro X-ray computed tomography for the microporous GDM microstructure and MPL cracks, and focused ion beam-scanning electron microscopy (FIB-SEM) for the nanoporous MPL matrix. The MPL matrix effective diffusion tensor is first computed from the FIB-SEM reconstructed 3D images considering Knudsen and Fickian diffusions. Then the GDM-MPL assembly effective through-plane diffusion coefficient is computed thanks to a mixed approach combining a continuum description for the MPL matrix and the explicit discretization of the MPL cracks and GDM pore space. The impact of MPL cracks on the assembly diffusion properties is evaluated by comparison with the case without cracks. The impact of the MPL penetration into the GDM and the impact of the GDM compressibility are evaluated using a diffusive resistance model, validated from the numerical simulations.

Participation

In-Person

References

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Session Classification: MS22

Track Classification: (MS22) Manufactured Porous Materials for Industrial Applications