Fibre-Electrolyte Interfaces in Multifunctional Composites Revealed with Focused Ion Beam

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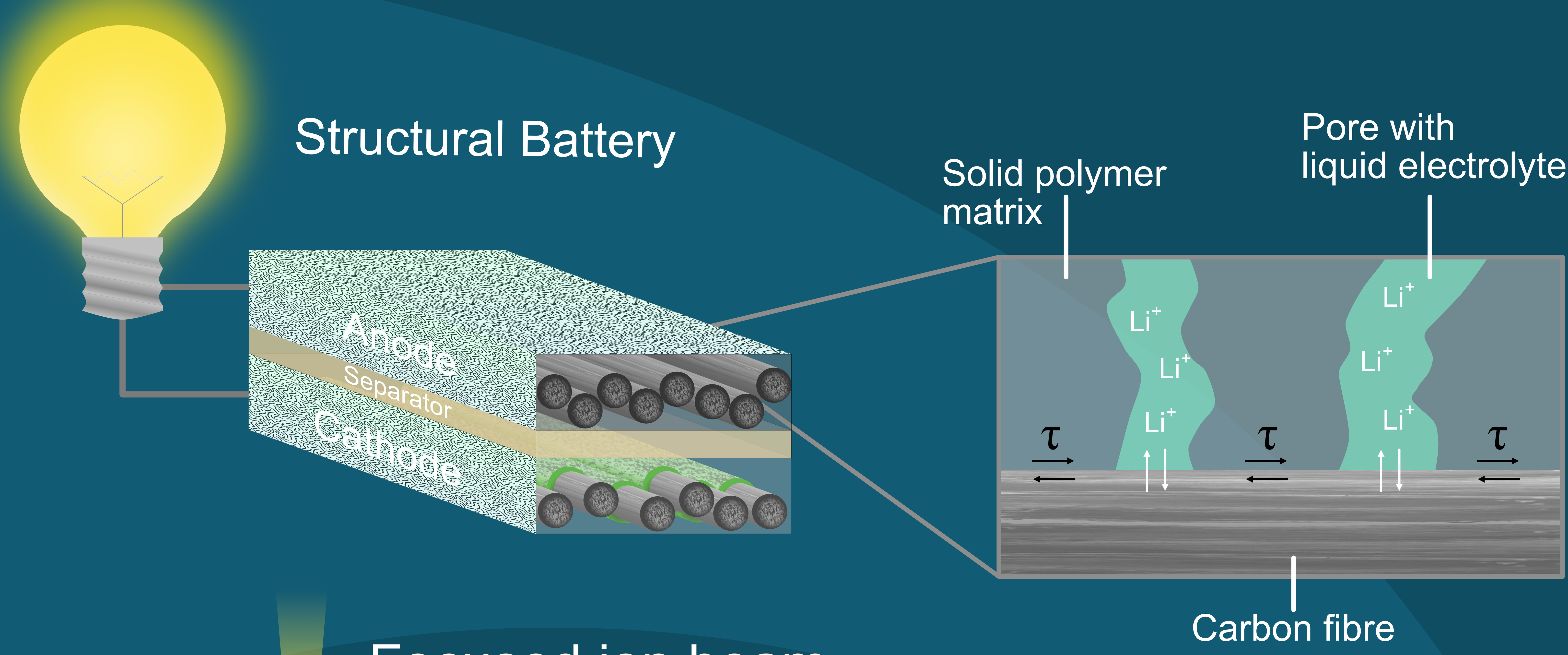

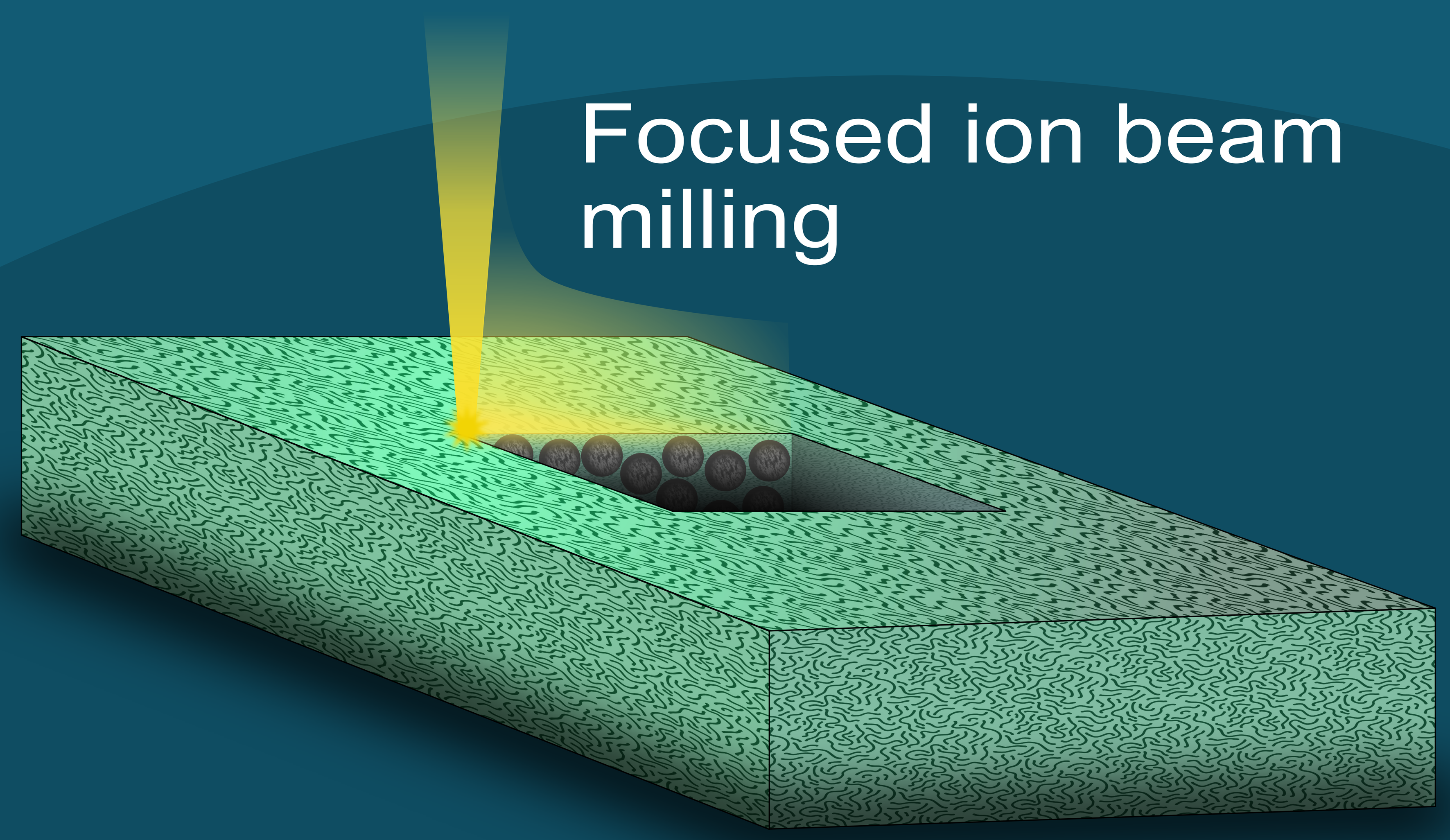

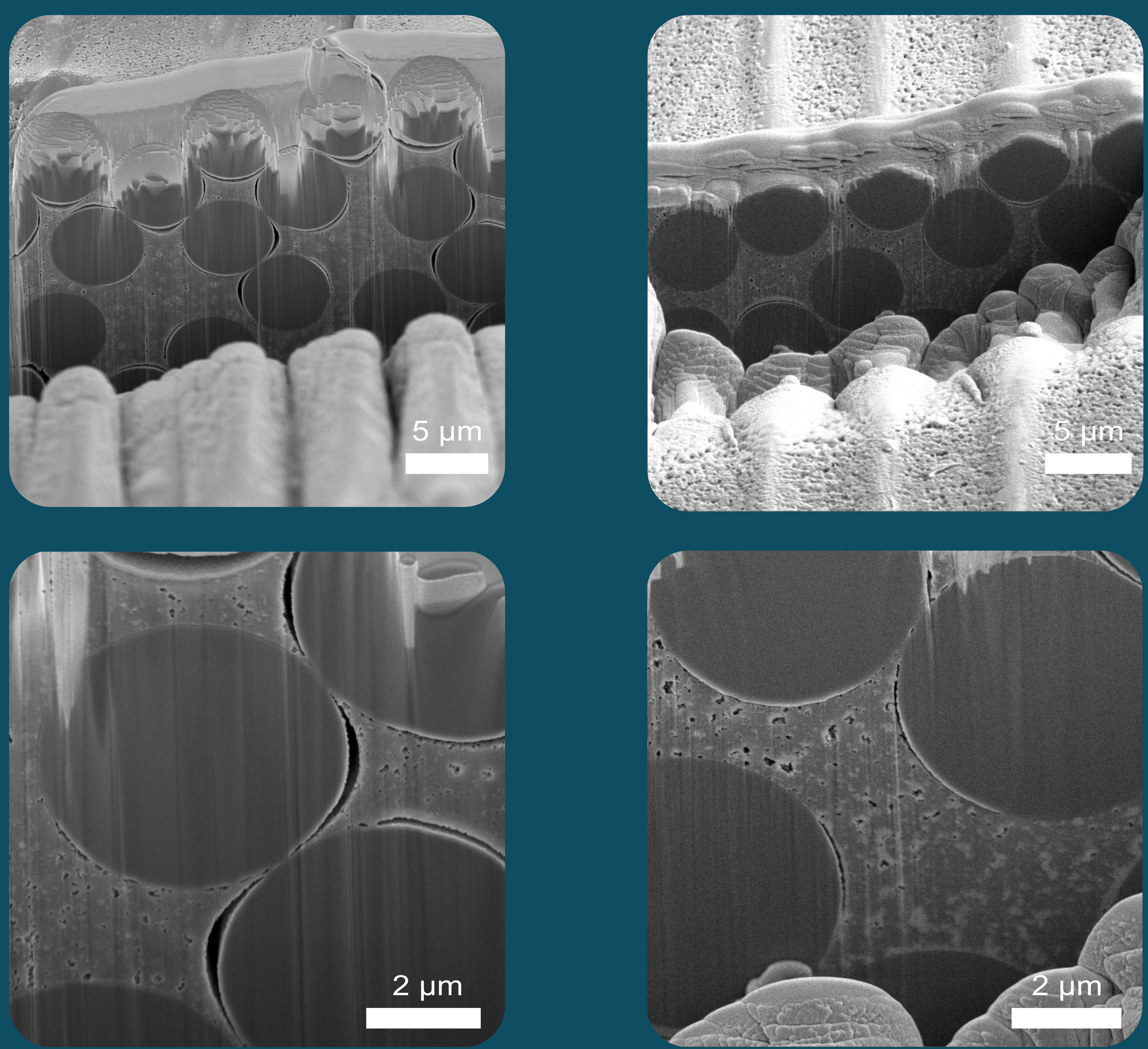

Electrolyte 1
PC/EC

Electrolyte 2
DMMP

Background

Carbon fibre reinforced composites and Li-ion batteries can be combined into multifunctional devices called structural batteries [1]. This is possible since carbon fibres can act simultaneously as reinforcement and as electrode. The matrix is a porous polymer percolated with liquid electrolyte [2], and acts as ion-conductor and load-distributor. Thus, there are two types of interfaces: fibre-solid interface and fibre-liquid interface [3]. To further improve structural batteries, it is crucial to understand these interfaces, their interplay, and how they can be tailored.

Experimental

We use Focused Ion Beam (FIB) to mill away material to reveal cross-sections of carbon fibre electrodes with different types of electrolyte formulations. Two electrolyte formulations are used: PC/EC and DMMP. The carbon fibres are T800. The system was electrochemically cycled and then rinsed and dried as to leave only fibre and polymer matrix. With the FIB a large trench is cut out with high beam current (42 nA) and then the cross-section surface is polished with low beam current (2.6 nA). The cross-section is protected from the ion beam by a deposited layer of Pt.

Outcome

The SEM images of the cross-sections captures the carbon fibres, the matrix and the interfaces between. In both matrix types, the pores are readily distinguished. At places the fibres have debonded from the matrix. This might be due to the swelling and contraction of the fibres during electrochemical cycling. DMMP proves to generate larger pores, but also less debonding. These findings will be correlated to mechanical testing. Still, DMMP appear promising with better adhesion which suggests better mechanical performance and larger pores which suggests better ion transport.

References

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