Performance improvements for the all-copper redox flow battery: membranes, electrodes, and electrolytes

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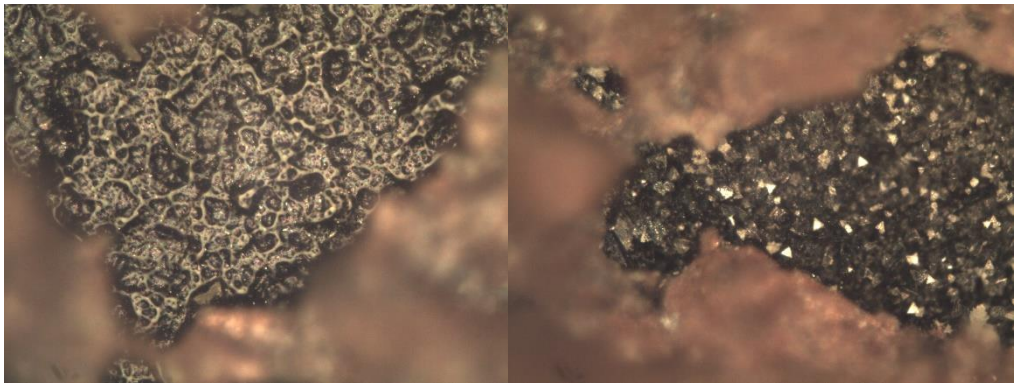

Figure 1A: Optical microscope images of CM-119 28 carbon ink coating on Sigracell FR-10 bipolar plate (left) and copper growth on the CM-119 28 carbon ink on the right at an x10 magnification.

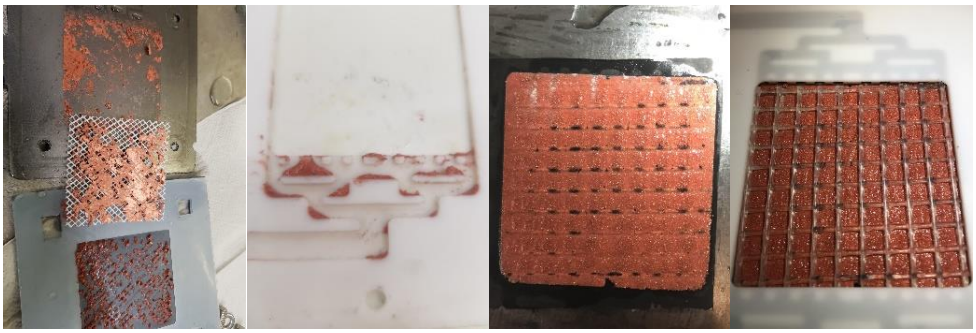

Figure 2A: Copper growth after operation of the redox flow cell under the standard conditions listed in Table 1. A) Copper growth on clean Sigracell FR-10, B) delaminated copper in the flow divider from copper growth on clean Sigracell FR-10, C) copper growth on the CM 119-28 coating, D) very little to no delaminated copper in the flow divider from copper growth on the CM 119-28 coating.

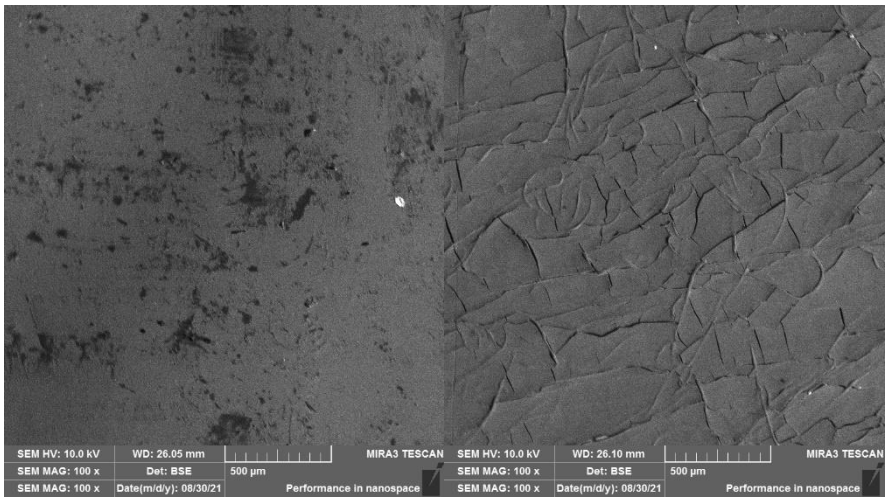

Figure 3A: SEM images of the FAP-330 (left) and AR-118 (right) membrane after cycling for 200 hours.