Optimizing the Porosity of Different PVDF Castings

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Introduction

The goal of this project is to study polyvinylidene difluoride (PVDF) when cast upon graphene used for proton exchange membranes. This study will look at how PVDF provides support to graphene membranes and creates consistent, uniform pores throughout the membranes. It will also test various PVDF casting techniques to determine which is best in terms of pore size and coverage.

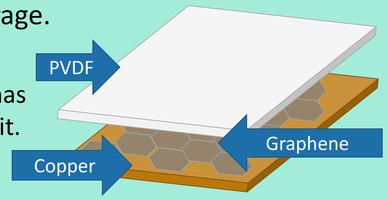

Figure 1. Membrane Layers: PVDF is cast on top of copper that has graphene chemically deposited on it.

Methods

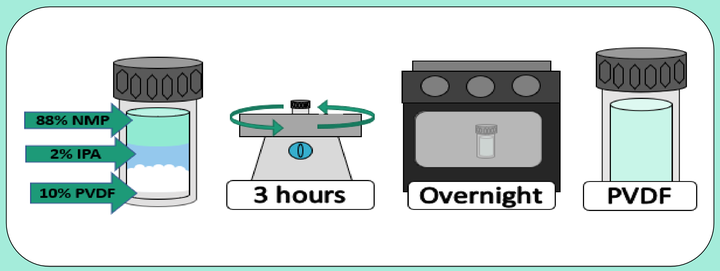

Figure 2. PVDF Solution

PVDF solution was made with 88wt% NMP, 2wt% IPA, and 10wt% of PVDF powder. It was mixed, baked and degassed, then stored.

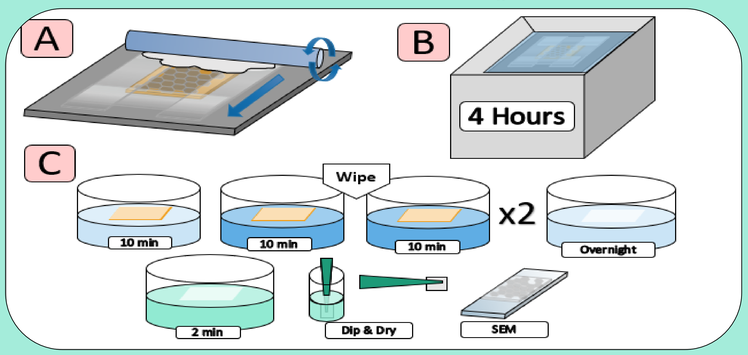

Figure 3. PVDF Casting

PVDF solution was cast using these techniques with variations in the tape thickness and solvent bath.

A) PVDF solution was cast onto copper with graphene using a rolling pin motion.
B) The copper was then placed in solvent bath for 4 hours.
C) Copper was etched off the membrane using APS (light blue), water (dark blue) and ethanol (teal).

Results

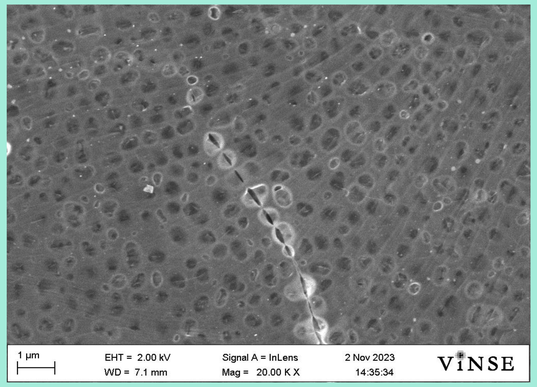

Figure 4. PES Castings in Water

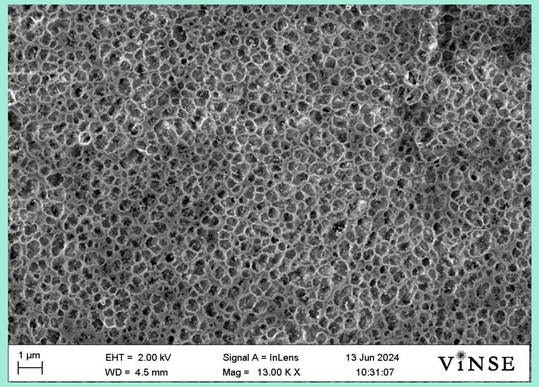

Figure 5. PVDF Castings in Water

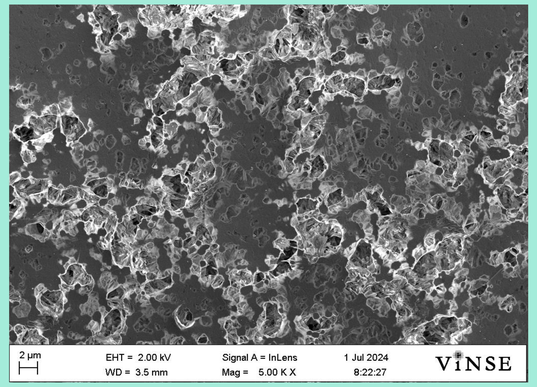

Figure 6. PVDF Castings in IPA

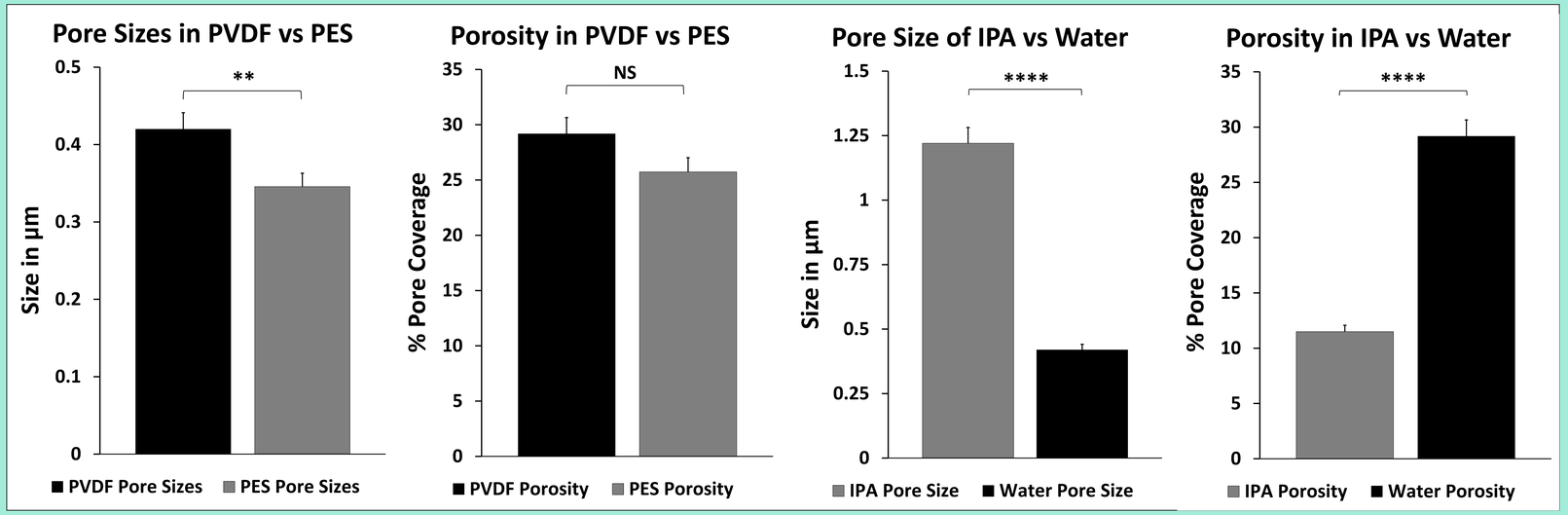

Figure 7. Comparing PVDF & PES Samples in Water & IPA

Figures 4-6 show from left to right: PES, PVDF in a water bath, and PVDF in an IPA bath. Figure 7 shows how PVDF compares to PES and how PVDF in water compares to PVDF in IPA. The average porosity and pore sizes were statistically compared. PES had a significantly smaller pore size compared to PVDF, but the compared porosity between the two was not significant. Additionally, PVDF in IPA had significantly larger pores than PVDF in water, but also a significantly smaller porosity.

Discussion

- Using a water solvent bath resulted in the largest porosity coverage.
- Prior research predicted that water is the best solvent for casting, and this research confirms that.
- PVDF on graphene responds best in a water bath, as it helps achieve the most consistent pores.

Conclusion

PVDF provides a sound structure for graphene, and the porosity and pore size can be adjusted with thickness and solvent baths.

Future Steps:

- Trying PVDF solutions with different chemicals.
- More solvent solution options, i.e., methanol.
- Using these membranes for ion transfers

References