Role of in-plane pores and graphitic domain size for mass transport in graphene oxide membranes*

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Mass transport through defective graphene sheets or along pristine graphene surfaces has been extensively studied and understood to the atomistic level. Even though the mass transport in GO membranes has been under close investigation, there are still open questions. Is the transport through in-plane pores similar to the transport in defective graphene sheets? Does the frictionless transport along pristine graphene be directly translated to understand the mass transport through GO membranes?

To answer these questions better, we undertook a series of experiments. By mild heat treatment we could show that the size of graphitic domains in GO sheets can be increased without changing the number of functional groups. This allowed us to investigate the mass transport through GO membranes depend on the size of graphitic domains without changing its chemistry. The enhanced graphitic domains lead to more frictionless water flux but also suppresses swelling of the GO membrane and smaller interlayer space. The latter appears to be more important to the water transport as the overall water flux is reduced with enhanced graphitic domains.

To further investigate the mass transport in GO laminates, we created artificial in-plane pores with precise control over number of functional groups and defect. This helps us to uncover that the surface tension of the liquid as well as functional groups around the pores play a major role in governing the mass transport. With that, the water transport through in-plane pores behaves vastly different compared to water transport through defective graphene.

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