Graphene multilayers for gas sieving

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Climate change combined with current geopolitical upsets are seriously demanding a conversion of our energy supply chain. Hydrogen is a carbon-free energy vector that can be prepared from a vast series of resources, even renewable, [1] but a low-cost strategy to isolate it is still challenging. Indeed, independently from the production approach, hydrogen is obtained in gas mixtures, mainly coupled with CO_2. [2,3] Membrane-based separation can be a suitable solution to prepare pure hydrogen, [4] but perm-selectivity performances of conventional materials are limited by the permeability/selectivity trade-off, named Robeson upper bound. [5] Nanosized composite membranes, fabricated using 2D materials, offer possibility to efficiently size-sieve gas molecules. Graphene-based self-assembled multilayers represent a tunable platform that allows to tailor final molecular architectures and resulting sieving performances, eventually surpassing current Robeson upper bound. Presented multilayers are prepared by an electrostatically ruled Layer-by-Layer self-assembled technique, alternatively exposing a polymeric substrate to a polyelectrolyte solution and a graphenic suspension. Each dipping step is followed by a rinsing in pH=7 water, to remove excess of deposited material (**Figure 1**, left). All perm-selectivities of prepared multilayers are determined by a standard manometric technique. In an attempt to improve poor level of permeability, the properties of the prepared multilayers are modified by post-fabrication modifications or by tuning process parameters of the self-assembly, such as annealing of the self-assembled multilayers or change in the concentration of solution/suspension used for the self-assembly (**Figure 1**, right). All prepared multilayers are extensively characterized in terms of morphology (SEM), elemental composition (XPS) and molecular architecture (XRD).

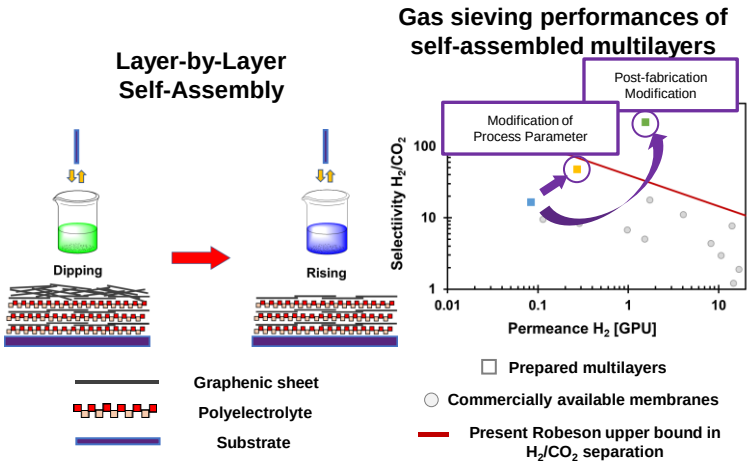

Figure 1: On the left, schematic representation of layer-by-layer self-assembly; on the right, perm-selectivity performances in H_2/CO_2 separation of some prepared multilayers compared with currently commercially available membranes (present Robeson upper bound in reported, red line).

References

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