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EDITORIAL

Characterization of thin films and membranes

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The study of interfaces is a well-established specialist area, affiliated in particular to physical chemistry. Many of the early analytical studies were underpinned by techniques refined from mainstream analytical sciences and originally applied to the study of the bulk material phase. Now, with the increasing refinement of thin-structure-forming methods, materials have been reconstituted as membranes and thin films. Here, interfacial properties (rather than bulk features) dominate. We now have a great diversity of materials-derived (film) systems that benefit from both established and more novel analytical approaches pioneered in the domain of interfacial science.

Inevitably, newer techniques have been added to the lexicon; PM-IRRAS (polarisation modulation infrared reflection spectroscopy) is one example from one of the articles in this special issue. Both physical (e.g. surface mechanics and structural profiling) and chemical analytical techniques have been applied to give a more holistic picture of both the interface and the subsurface. Many more methods have been added to this arsenal in recent years, including spectroscopic, microscopic, electrochemical and even mechanical approaches. These methods enable investigations of all sorts of thin films and membranes in situ and ex situ with extremely high lateral resolution.

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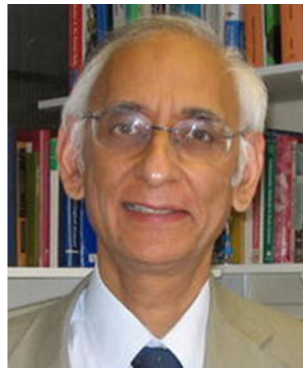
There are, of course, fundamental questions that still need to be answered in this field. Such questions apply not only to the full gamut of polymeric, inorganic, and hybrid films and membranes, but also to the internalised—yet still exposed—elements of such materials, as embodied, say, by their micro- and nanopores. Whatever the bulk phase properties of a material (which traditional materials science tends to focus upon), the “distorted” organisation observed at the nominally crystalline and amorphous mesoscale at and near the interface can result in quite different material properties to those presented to the outside world. At a basic level, studying this altered organisation provides a route to understanding thermodynamically programmed pathways to structure, along with their kinetic determinants. This is especially so given that the external environment—be it vacuum, ambient air or liquid—conditions the final outcome.

Beyond their inherently interesting surface-related properties, thin-material constructs present practical opportunities that can be utilised by improving our understanding of and better harnessing their fundamental properties. Membrane technology is a long-established field where just such an understanding has led to important applications, particularly in separation science. These have ranged from desalination, particulate/molecular sieving and battery/fuel cell production through to haemodialysis. Ultimately, the stability of these functions is affected by the stability of the membrane surface and its resistance to surface contamination: so-called fouling. These are often assumed to be vague processes that are somehow more random than Langmuirian adsorption, but in reality this assumption is made because their complexity defies our predictive models. This is especially the case for biological fouling in applications such as clinical membrane separators and biosensors.

Thin films and membranes are now used extensively, and are being developed as substrates for molecular selfassembly, bioaffinity, imprint phases for nonbiological binding (molecular imprint polymers) and nanoporous molecular separators, such as those employed for DNA selection. There have also been advances in structure scaling, such as those achieved through the use of monomolecular barriers (e.g. graphene), electronically addressable films (e.g. for plastic and printed electronics) and supported liquid phases (e.g. based on biomimetic lipid bilayers).

So, in principle, there is no limit to the materials components that can be used, and no limit to the functionality that can be achieved. The articles included in this topical issue demonstrate the synergistic contribution of analytical techniques that are used to characterise the array of properties presented by thin films and membranes. Such techniques will provide the basis for understanding these dimensionally unique solid and liquid phases so that they can be used in scientific advancement and applications development.

In this topical issue dedicated to the characterisation of thin films and membranes, we have gathered together a unique collection of reviews and original papers by the best scientists in the field. Each contribution focuses on different approaches and techniques that are currently used to study and manipulate these assemblies. Evidently, it is almost impossible to cover all of the techniques utilised in this field, but we hope that this original collection will provide the reader with useful insights into the current status of this wide field of activities, and may also promote the adoption of new methods of research into thin films and membranes.



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