3D printing functional nanoporous membranes and separation materials

Ludovic F. DUMEE, Hari Balakrishnan, Laura Carvalho, Robel Tekle, Hassan Arafat (Arial 10)
Khalifa University, Research and Innovation Center on 2D Nanomaterials (RIC2D), Abu Dhabi, United Arab Emirates
Ludovic.dumee@ku.ac.ae

Abstract

Over the past 20 years, 3D printing technologies have emerged as innovative tools to generate macro-porous materials, with potential in complex structures impossible to otherwise develop by traditional manufacturing. More recently, advanced composite materials have been developed at the mili and micro scale following progress in new polymers and resins formulations as well as greater resolution control for both Fused Deposition Modelling and Dynamic Light Polymerisation. Breaching the micron-scale barrier, to generate nano-porous materials has however remained to date a major challenge, due to either rheological limitations or minimum printable pixel size achievable. New strategies arising from polymer monoliths development have however emerged to generate ultra-porous materials, with macron-sized thicknesses and yet nanoscale pores. Our team has developed innovative strategies based on advanced resins formulations to print nano-porous membranes, and nano-textured catalysts as well as adsorbents. In this presentation, the feasibility to develop complex 3D membrane architectures as well as functional 2D nanomaterials composites with this novel process at scale will be demonstrated for a range of chemistries and applications. Nanocomposite structures with excellent nano-load distributions and incorporation into porous polymeric matrixes are critical to achieving scale of production and roll-to-roll 3DP functional films production will also be demonstrated. In this presentation, the development of nanoporous membranes with near isoporous structures with pores ranging from as low as 10 nm and up to hundreds of nanometers will be demonstrated. Functional complex 3D structures, showcasing the potential of various ranges of nanomaterials directly into the membranes will be showcased with nanosheets and nanoparticles to generate photo-catalytic and electrocatalytic membrane reactor systems, allowing for simultaneous filtration across the pores and reactions to occur at the membrane surface. The scalability of the approach will also be demonstrated to produce at scale (few meters long) consistent membranes by 3D printing.

References

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