BIOENGINEERING, BIOMEDICAL, EDUCATION, MANUFACTURING & MATERIALS FRONTIERS

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Publications

1. Samant, S. et al., "Effect of Molecular Weight and Layer Thickness on the Dielectric Breakdown Strength of Neat and Homopolymer Swollen Lamellar Block Copolymer Films." ACS Appl. Polym. Mater. 2020, 2,8, 3072-3083, https://doi.org/10.1021/acsapm.0c00127

2. Bhadauriya, S. et al., "Nanoscale Pattern Decay Monitored Line by Line via In Situ Heated Atomic Force Microscopy." ACS Applied Materials Interfaces, 2020, 12(13): 15943-15950.

3. El Samak, A.A. et al., "Designing Flexible and Porous Fibrous Membranes for Oil Water Separation- A Review of Recent Developments." Polymer Reviews, 2020, 1-46, Taylor & Francis. DOI: 10.1080/15583724.2020.1714651

4. Huang, Z. et al., "Networked Zwitterionic Durable Antibacterial Surfaces." ACS Applied Bio Materials, 2020, 3(2): 911-919.

5. Wu, L. et al., "Facile Synthesis of Nanoparticle-Stacked Tungsten-Doped Nickel Iron Layered Double Hydroxide Nanosheets for Boosting Oxygen Evolution Reaction." Journal of Materials Chemistry A, 2020, 8(16): 8096-8103.

6. Ponnamma, D. et al., "White Graphene-Cobalt Oxide Hybrid Filler Reinforced Polystyrene Nanofibers for Selective Oil Absorption." Polymers (Basel), 2020, 12(1): 4.

7. Zhang, X., et al.. "Dynamical Correlations for Statistical Copolymers from High-Throughput Broad-Band Dielectric Spectroscopy." ACS Combinatorial Science, 2019, 21(4): 276-299.

8. Basutkar, M. N., et al.. "Aligned Morphologies in Near-Edge Regions of Block Copolymer Thin Films." Macromolecules, 2019, 52(19): 7224-7233.

9. Hayirlioglu, A., et al.. "Block copolymer ordering on elastomeric substrates of tunable surface energy", Emergent Materials, 2019, 2 (1), 11-22.

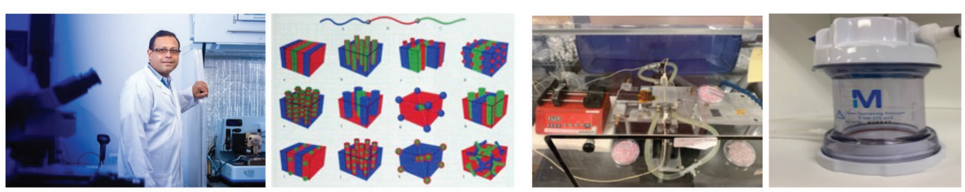
10. Dongre, R. S., et al. "Natural polymer based composite membranes for water purification: a review." Polymer-Plastics Technology and Materials, 2019, 58(12): 1295-1310.

11. Wang, X. T., et al. "Nanoimprint Directed Assembly of Associating Polymer-Grafted Nanoparticles for Polymer Thin Films with Enhanced Stability." ACS Applied Polymer Materials, 2019, 1(12): 3242-3252.

Dr. Karim is a Fellow of the American Physical Society for his pioneering research on polymer thin films and interfaces, polymer brushes, blend film phase separation, thin film de-wetting, pattern formation in block copolymer films and the application of combinatoric measurement methods to complex polymer physics. He is a Fellow of the American Association of Advancement of Science (AAAS). His research is funded by the National Science Foundation, the Department of Energy, the Department of Defense and industry. His recent research is focused on novel processing approaches as applied to block copolymers for functional applications of nanotechnology, ranging from advanced energy to sustainability solutions. Some examples of his current projects include entropy-enthalpy compensation in relaxation of nano-patterned polymer nanocomposites, block copolymer compatibilized phase-separation of polymer blends for artificial color, block copolymer nanocomposites based dielectric capacitors for energy storage, ordering of block copolymers with ionic liquids, patterning of ionic liquid crystalline and conductive polymers, phase-separation of polymer grafted nanoparticle brushes, functionalized polyolefin films, bionanocomposite polymer films from biomaterials (CNC and Chitin, Chitosan), multilayer IR management coatings, triboelectric nanogenerators, and flexible super-capacitors. Many of these projects involve the use of Direct Immersion Annealing (DIA) and Cold Zone Annealing (CZA) techniques.

DIRECT IMMERSION ANNEALING (DIA)

Dr. Karim has developed a novel technique that uses solvent instead of heat to bind individual single layer polymers into multi-layered block copolymer films. This technique, also known as direct immersion annealing (DIA), enables copolymer layers to self-assemble and form multilayered block copolymer films in a solvent mixture bath. Further, this technique when used in combination with an industrially relevant roll-to-roll processing method can produce copolymer layers as thin as one-millionth the width of a human hair with nanometer scale precision alignment in a cost-effective way. Another novel feature of this technique is that it enables customization of the copolymer block based on specific use, which has great utility for high-tech markets. Additionally, such multilayer block copolymer films and coatings have utilty in food packaging to infra-red reflective films for energy efficient buildings to liquids separation membranes ***(https://twitter.com/NSF_MPS/status/1174051188997853185)***.



The Atomic Force Microscope used to characterize block copolymer thin film membranes materials whose diverse possible structures are illustrated in cartoon, that are processed by CZA zone-refinement set-up and tested using water/oil separation assembly.

COLD ZONE ANNEALING (CZA)

In the energy storage field, Dr. Karim has developed highly refined block copolymer materials for novel high energy density capacitors for pulsed power. More specifically, he has developed aligned nanometric layers of block copolymers by adapting a technology used in processing semiconductors that involves processing films over a thermal gradient in a dynamic fashion, by a method developed in-house termed Cold Zone Annealing (CZA). These methods produce defect-free multilayer films that prevent electrical breakdown at high voltages and allow for high energy storage capacity. This is beneficial to the industry as it can use cheaper amorphous polymers in high energy storage devices instead of the semi-crystalline polymers that are currently used. This research was funded by an NSF Center Award.

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