Structured block copolymer thin film composites for ultra-high energy density capacitors\textsuperscript{1} SAUMIL SAMANT, University of Akron, SHIME LIS HAILU, Howard University, CHRISTOPHER GRABOWSKI, MICHAEL DURSTOCK, Air Force Research Lab, WPAFB, DHARMARAJ RAGHAVAN, Howard University, ALAMGIR KARIM, University of Akron — Development of high energy density capacitors is essential for future applications like hybrid vehicles and directed energy weaponry. Fundamentally, energy density is governed by product of dielectric permittivity $\varepsilon$ and breakdown strength $V_{bd}$. Hence, improvements in energy density are greatly reliant on improving either $\varepsilon$ or $V_{bd}$ or a combination of both. Polymer films are widely used in capacitors due to high $V_{bd}$ and low loss but they suffer from very low permittivities. Composite dielectrics offer a unique opportunity to combine the high $\varepsilon$ of inorganic fillers with the high $V_{bd}$ of a polymer matrix. For enhancement of dielectric properties, it is essential to improve matrix-filler interaction and control the spatial distribution of fillers for which nanostructured block copolymers BCP act as ideal templates. We use Directed Self-assembly of block copolymers to rapidly fabricate highly aligned BCP-TiO$_2$ composite nanostructures in thin films under dynamic thermal gradient field to synergistically combine the high $\varepsilon$ of functionalized TiO$_2$ and high $V_{bd}$ of BCP matrix. The results of impact of BCP morphology, processing conditions and concentration of TiO$_2$ on capacitor performance will be reported.

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