Perfluoropolyether-based Polymethacrylate Molecular Bottlebrush as Low Surface Energy Additives to Fiber Forming Thermoplastics

*Liying Wei[1], Philip J. Brown[2], Igor Luzinov[2]

[1]Ph.D. Candidate, Department of Materials Science and Engineering, Clemson University,
[2]Professor, Department of Materials Science and Engineering, Clemson University
liying@g.clemson.edu and luzinov@clemson.edu

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Abstract: For decade, water and oil repellency of fiber forming thermoplastics has been achieved with introduction of long-chain perfluoroalkyl substances and moieties (PFASs, C_nF_{2n+1}, $n \geq 7$). However, they have been phased out of industrial production and textile applications due to their bioaccumulative and toxicological impact. To this end, we synthesized novel perfluoropolyerther (PFPE)-based methacrylate monomer (FM) by reacting PFPE-based alcohol with methacryloyl chloride. The resulting monomer was precipitated to prepare PFPE-based polymethacrylate polymer (PFM), which does not possess long-chain perfluoroalkyl segments and serve as low surface energy additives to fiber forming therrmoplastics. The surface properties such as wettability and morphology of PFM/thermoplastic polymer films were studied using contact angle measurements and atomic force microscope. It was found out that PFM, when added to polyethylene terephthalate (PET), nylon 6, and poly(methyl methacrylate) (PMMA) films, readily migrates to the film surface and brings significant water and oil repellency to the thermoplastic boundary. The addition of this PFM polymer to thermoplastics, even at relatively low concentration, allows the polymer films reaching a level of oil wettability and surface energy lower than that of polytetrafluoroethylene (PTFE/Teflon). We associate this superiority of the polymer in achieving high water and oil repellency with its ability to form molecular bottlebrushes on polymer film surfaces. Therefore, the polymer can be considered as safer replacements for additives containing long-chain perfluoroalkyl substances.