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Hydrophobic Recovery of Plasma Modified Electro-spun versus Smooth Polymer Surfaces

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Synthetic polymers are well known to be hydrophobic (non-wetting) in their natural state, due to their inherently low surface free energy, γ (in mN/m). Surface modification of polymers by exposure to cold plasma for enhanced wettability is practiced on vast industrial scales (i) by atmospheric pressure (AP) "corona"discharges since the 1940s; (ii) by other cold plasma processes, either at AP or under partial vacuum in more recent decades. Hereby, polar functional groups, usually bearing O and/or N atoms, become covalently grafted to the outermost polymer surface.
A well documented drawback of such grafting reaction by (i) and (ii) above is known as "hydrophobic recovery"or "ageing": thereby, the increased γ of freshly treated polymer partially reverts to its initial low value (about 28 mN/m for polyethylene or polypropylene, from values as high as > 50 mN/m immediately after treatment). The reason for this thermodynamically driven phenomenon is that polar moieties become buried up to tens of nm below the outer surface by macromolecular "reptation", motion that occurs at normal (non-cryogenic) temperature.

This laboratory has for many years been modifying polymer surfaces by plasma to promote adhesion of living cells for biomedical applications. The solid polymers have been either (a) normal films, typically 50 μm thick and possessing smooth top surfaces; (b) fibrous mats composed of > 90% void random networks of submicrometric electro-spun fibrils. We have certain evidence, based on time-dependence of water contact angle (WCA) measurements, that (b) might resist ageing more than (a). A possible reason for this might be much higher surface-to-volume ratio of (b), which favours surface-near cross-linking of polymer chains by ion bombardment and/or VUV irradiation. We present preliminary results based on WCA and surface analytical (XPS) measurements.

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