A Closer Look at the Carbon/Polymer Interface – An AFM Study

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The polymer/carbon interface plays a major role in many polymer matrix composites which use carbon-based fillers/fibres/nanoparticles [1]. Carbon-based particles are widely utilised in polymer composites and nanocomposites for various applications such as; tyre rubbers (carbon black), advanced membranes (carbon nanotubes), medical equipment and super-strong construction materials (carbon fibres) [2-3]. With advances in carbon nanostructures such as graphene [4] and carbon nanotubes [5] the potential for new materials created by polymer/carbon composites is further increasing. However, the carbon/polymer interface itself is poorly understood at a fundamental level [6]. Polymers behave very differently at an interface than in the bulk. This research is focused on exploring the polymer/carbon interface on the nanoscale, primarily using atomic force microscopy (AFM) techniques. Styrene-butadiene random copolymers with varying molecular weights were spin coated onto both mica and graphite surfaces, and the resulting morphology of the polymer aggregates were probed using tapping mode AFM in air. A comparison between the polymer behaviour on the mica surface and the graphite surface is presented.

Figure 1 shows the same concentration of the styrene-butadiene polymer on a mica surface (A) and a graphite surface (B). The morphology of the polymer aggregates are very different on the two surfaces. On the mica surface spherical-cap nanodroplets form with an average height of 87 nm; this morphology can be explained by dewetting; it is not favourable for the hydrophobic droplets to interact with the hydrophilic surface, therefore to reduce free energy, the chains self-assemble into droplets. On the graphite surface a continuous polymer network is formed with an average height of 42 nm, the polymer morphology is much flatter on the graphite; this is attributed to graphite being hydrophobic and the favourable physical interactions between the surface and the polymer.

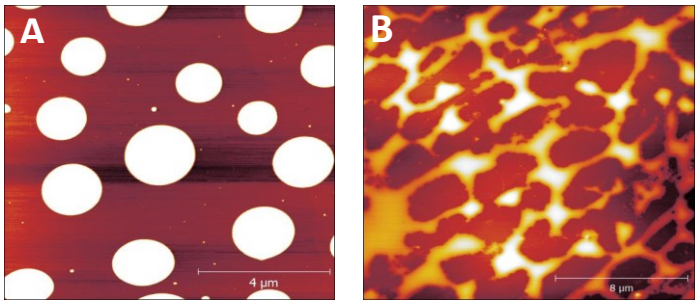

Figure 1: AFM images showing a styrene-butadiene random copolymer (M_n = 85 kg/mol) at a concentration of 3.71 mg/ml (= 1c*), on (A) a mica surface and (B) a graphite surface.

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