471f Moisture at Buried Polymer Interfaces: a Destabilizing Force

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From an engineering perspective, avoiding atmospheric water is generally desirable to prevent corrosion, degradation, and adhesion loss. Adhesion between polymers and aluminum surfaces is necessary for safe replacement of the rivets on aircraft with polymeric-based adhesives. These joints are exposed to the elements and thus the adhesive must be effective even in moist conditions. However, water is known to be detrimental to the adhesive strength between polymers and metal surfaces. The adhesion loss from water exposure does not generally correlate with moisture solubility of the polymer; instead the supporting surface of the polymer appears to be the controlling factor in the adhesion. Here, we explore the adhesion of a model polymeric material, polymethylmethacrylate, to aluminum surfaces in the presence of moisture. The distribution of water within the polymer film is directly measured using neutron reflectivity, while the adhesive strength of the joint is measured using the shaft-loaded blister test. Moisture accumulates at the buried polymer/metal interface. Several adhesion promoters were examined to determine their effect on this interfacial moisture content. The loss of adhesive strength upon exposure to moisture correlates directly with the interfacial water content. Surface modification methods that decrease the interfacial water content are used to tune the adhesive strength in moist environments. Minimization of the interfacial water concentration does not however result in the best adhesion in moist environments as interplay between the dry adhesion and water content exists.