The effect of Polydopamine thermal treatment on the adhesion of Poly(lactic acid) (PLA)-Metal co-molded joints.

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Abstract.

The molecular interaction in polymer/metal oxide interfaces is of paramount interest for polymer composite applications that encompass co-molding of polymer-metal joints, additive manufacturing and mold release. The type of polymer and/or metal determines the bonding strength of the interface and primers are often applied to alter the interfacial properties of metals, according to the needs of the respective application. However, the performance of commercial primers highly depends on the type of metal and often cannot provide good control on the interfacial bonding strength. In this work, using a polymer matrix of growing interest, i.e. poly(lactic acid) (PLA) and two metals of significant commercial importance, i.e. titanium (Ti) and stainless steel (SS), we show the potential of biomimetic polydopamine[1] (PDA) layers to control polymer-metal adhesion from strong bonding to release. In particular, PDA layers are deposited on Ti and SS wires and the wires are then embedded in a PLA matrix to produce specimens, which are then subjected to pullout tests. The results show that even though PLA bonds are significantly weaker to Ti than to SS, after the PDA layer is deposited both metals exhibit similar adhesion values, which are significantly higher than for their unmodified counterparts. A simple thermal treatment of the PDA coated wires prior to the co-molding process results in a sharp increase of the bonding strength at low temperatures, followed by a gradual drop at higher temperatures, providing control over adhesion in polymer-metal interfaces. Based on the substrate-independent nature of PDA adhesion[2] we propose that this phenomenon we discovered can be successfully applied to surfaces other than metals, raising high expectations for future polymer composite applications.

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