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Nanoscale molecular adhesion layers for silicone bonding

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Adhesives for binding materials together are very important in the industry. Traditional methods for this include priming and gluing on the surfaces of the materials used. The traditional methods are not always ideal, considering adhesion strength and over time potential release of hazardous residues from the adhesive layers. Especially for medical applications, there is a great need for adhesion solutions that won't leach chemicals over time. Silicones are the most used class of polymers in the MedTech industry and are therefore a desirable development target concerning adhesion layers. A new adhesion technology using nanoscale polymer brush layers for binding plastics has emerged. This new nanotechnology was first demonstrated at Aarhus University in 2013 and holds a great potential as a next-generation adhesion technology. For this study, different types of nanoscale polymer brushes were synthesized by surface-initiated atom transfer radical polymerization on MedTech grade titanium surfaces. The polymer brushes had chemical functionalizations made to take part in the silicone curing process. Evaluating the adhesion properties were done by molding medical grade 2-component platinum (Pt) cured silicones on top of the modified titanium surfaces. The silicone molded surfaces where subjected to tensile testing and their tensile strength was used as a measure of the adhesion strength. In this work, a nanoscale polymer brush structure containing Si-H groups was found to promote adhesion to silicone, governed by entanglement and covalent bonding on the nanoscale. The adhesion was strong enough to result in cohesive fracture in the bulk silicone during testing, which is the maximum achievable. A novel nanoscale polymer brush layer with the ability to bond silicone was synthesized. This nanolayer yields an adhesion solution that doesn't leach chemicals over time to the surroundings. This finding is of great significance for silicone-based products in the MedTech industry.

Recent Publications

1. S U Nielsen, L Koefoed, H Lund, K Daasbjerg and S U Pedersen (2016) Wohl-Ziegler bromination of electrografted films for optimizing atom transfer radical polymerization. Electroanalysis 28:2849–2854.
2. K Shimizu, K Malmos, A H Holm, S U Pedersen, K Daasbjerg, et al. (2014) Improved adhesion between PMMA and stainless steel modified with PMMA brushes. ACS Appl. Mater. Interfaces 6:21308–21315.
3. K Shimizu, K Malmos, S-A Spiegelhauer, J Hinke, A H Holm, et al. (2014) Durability of PEEK adhesive to stainless steel modified with aryldiazonium salts. International Journal of Adhesion & Adhesives 51:1–12.
4. J Iruthayaraj, S Chernyy, M Lillethorup, M Ceccato, T Røn, et al. (2011) On surface-initiated atom transfer radical polymerization using diazonium chemistry to introduce the initiator layer. Langmuir 27:1070–1078.

Biography

Stefan Urth Nielsen, an Industrial PhD student is doing his work partly at Aarhus University and partly at the nanocoating company RadiSurf ApS. He is utilizing his skills within organic chemistry to construct nanoscale polymer layers on surfaces with the specific aim of promoting nano-based adhesion to plastics. His major focus revolves around the use of polymer brushes as adhesion promoters. Especially, chemical surface activation and surface-initiated polymerizations are his prime areas of work regarding the fabrication of nanopolymer layers. His work his highly interdisciplinary and is bridging academia and industry to make the next-generation of adhesion solutions based on nano layers.

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