Metallization of Polymers

The metallization of polymers, a type of surface functionalization, is of critical importance in applications where the bulk properties of the polymer, but the surface properties of the metal are required. However, due to vastly different surface energies, getting a metal to adhere strongly to a polymer is notoriously difficult. Physical vapor deposition (PVD) processes are gaining industrial relevance enabling non-toxic processes for the metallization of polymers. Although the PVD metallization of polymers has been studied for decades, a thorough understanding of the metallization process, as it affects metal-polymer interactions at the interface that lead to strong adhesion, remains to be lacking.

Nevertheless, a solid understanding of metal-polymer interaction as a result of metallization-related PVD processing is of ever-increasing importance as demands on metallized polymers increase. Load-bearing parts in harsh environments, such as polymer implants in the human body, are particular examples of this, and polymer-substrate-based flexible electronics is another.

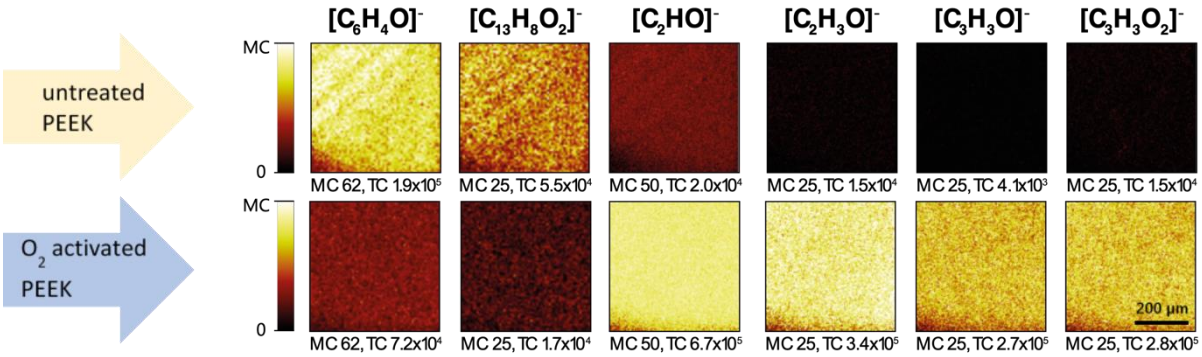

Figure 1. Time-of-flight secondary ion mass spectroscopy (ToF-SIMS) intensity maps for oxygen containing ionized molecular fragments. In the untreated case, the molecular fragments correspond to portions of the PEEK molecule (and contain aromatic ring structures),

We study the effects of different processing stages involved in PVD metallization (namely surface activation, and the metallization itself) on the metal-polymer interphase. Specifically, we examine the surface and interphase chemistry as a result of the different stages, as well as the role that the adatom energetics plays on macroscopic adhesion of the metal film on the polymer substrate [1].

In our laboratories we have different setups varying from off-axis sputtering [2] to High-power impulse magnetron sputtering (HiPIMS) which allow us to control the adatom energies from very low to very high ends. The control over adatom energies enables fine tuning of the material microstructure. Therefore, appropriate microstructure and crystalline phase mix of the evolved coatings are systematically studied to explore the interface between polymer and metal. Moreover, tailored microstructures on the implant surface help engineering the human-implant interface and the osteoconductive nature of the surfaces investigated via protein adsorption and subsequent, cell fate decision studies.

The goal of this research topic, then, is to gain a more fundamental understanding of the metal-polymer interaction and exploit this understanding in applications covering functional biomedical coatings to smart flexible devices.

References:

[1] This project is performed in collaboration with Oerlikon Balzers Coating Lt, Iramali18, P.O. Box 1000, 9496 Balzers, Liechtenstein

[2] A project on facing target sputtering was performed in collaboration with Evatec AG. The work was financed from the Innosuisse project (Project Nr. 18940.2 PFNM-NM).