Mechanical Properties of Plasma Immersion Ion Implanted PEEK for Bioactivation of Medical Devices.

Wakelin EA[1], Fathi A[2], Kracica M[3], Yeo GC[4,5], Wise SG[6], Weiss AS[4,5], McCulloch DG[3], Dehghani F[2], Mckenzie DR[1], Bilek MM[1].

Author information

ACS Appl Mater Interfaces. 2015 Oct 21;7(41):23029-40. doi: 10.1021/acsami.5b06395. Epub 2015 Oct 7.

Abstract

Plasma immersion ion implantation (PIII) is used to modify the surface properties of polyether ether ketone for biomedical applications. Modifications to the mechanical and chemical properties are characterized as a function of ion fluence (treatment time) to determine the suitability of the treated surfaces for biological applications. Young's modulus and elastic recovery were found to increase with respect to treatment time at the surface from 4.4 to 5.2 MPa and from 0.49 to 0.68, respectively. The mechanical properties varied continuously with depth, forming a graded layer where the mechanical properties returned to untreated values deep within the layer. The treated surface layer exhibited cracking under cyclical loads, associated with an increased modulus due to dehydrogenation and cross-linking; however, it did not show any sign of delamination, indicating that the modified layer is well integrated with the substrate, a critical factor for bioactive surface coatings. The oxygen concentration remained unchanged at the surface; however, in contrast to ion implanted polymers containing only carbon and hydrogen, the oxygen concentration within the treated layer was found to decrease. This effect is attributed to UV exposure and suggests that PIII treatments can modify the surface to far greater depths than previously reported. Protein immobilization on PIII treated surfaces was found to be independent of treatment time, indicating that the surface mechanical properties can be tuned for specific applications without affecting the protein coverage. Our findings on the mechanical properties demonstrate such treatments render PEEK well suited for use in orthopedic implantable devices.

KEYWORDS:

Elastic modulus; PEEK; biocompatible; ion modification; nanoindentation; plasma immersion ion implantation; polyether ether ketone