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In-vitro adhesion life time of DLC coatings and XPS interface analysis

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Diamond-like carbon (DLC) coatings are today used in numerous industrial applications due to their outstanding properties like low friction coefficient, extreme hardness, high wear resistance, and chemical inertness. Despite this, their application in implants, especially load-bearing joints, was not yet successful due to improper interface design. Most implants failed because of the delamination of the coating and not due to the failure of the coating itself. Different processes have so far been identified as responsible for the delamination, mainly stress corrosion cracking and crevice corrosion and are currently under investigation. These processes may be very slow but nevertheless, within a few years considerable parts of the coating may have delaminated leaving behind a surface which is quite rough and therefore acts like a rasp. As DLC has high residual stresses in the order of a few GPa, it's adhesive interface is especially prone to stress corrosion cracking. First results of these newly developed methods to determine the adhesion life time of coatings will be shown. These methods also allow to increase the speed of the delamination process yielding in return estimations of adhesion life time under normal working conditions.
We present results on DLC (produced by rf plasma-activated chemical vapor deposition) coated CoCrMo substrates, a widely used modern implant material. Investigations with FIB and TEM will show that the failure is located at the reactively formed interface between DLC and the substrate. Detailed XPS analyses allow not only to determine the exact chemical composition at the very thin interfaces, but also yield information on the chemical states correlating with the crack advancement at the interface. In combination, this is a prerequisite for possible improved adhesion interlayers with much longer life time expectance.

Keywords
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