Characterization of VPS coated CFR PEEK interface and substrate

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INTRODUCTION: The use of carbon fibre reinforced (CFR) PEEK in orthopaedics has been increasingly growing in the last few years. Its application as a long term bearing component looks promising, especially considering its wear resistance properties [1]. In order to reach a good level of bone integration though, porous coating interfaces have to be realized on the material surface [2]. Since PEEK has shown to undergo significant changes in crystallinity and microstructure due to thermal and stress history [3], investigating the evolution of those properties after thermo-mechanical coating processes is of great interest. This work is aimed to characterize the crystallinity of injection moulded vacuum plasma sprayed (VPS) coated CFR PEEK samples, and to study the evolution of the crystal phase during all the coating process steps.

METHODS: PAN based CFR PEEK samples have been injection moulded starting from granules, and have been sandblasted and VPS coated with Titanium beads. Crystallinity measurements have been performed by DSC analysis (heat cycle from 30°C to 400°C at 20°C/min) on granules and injection moulded material, in order to provide information on crystallinity evolution during the injection moulding and after each coating process step. A detailed electron microscope image analysis has been performed, in order to assess the reliability of the coating and the substrate morphology. Sample sections have been examined with SEM-EDX to evaluate coating appearance; focused ion beam (FIB) was employed to etch the surface and look at the substrate morphology before and after coating operations

RESULTS: Crystallinity changes from granules to the injection moulded material, as well as after sandblasting and coating process (Table 1), demonstrating that thermal and stress history affect the microstructural properties of the composite. Coating morphology is acceptable, and substrate appearance in terms of fibre orientation and integrity seems to be unaffected by coating procedures (Figure 1).

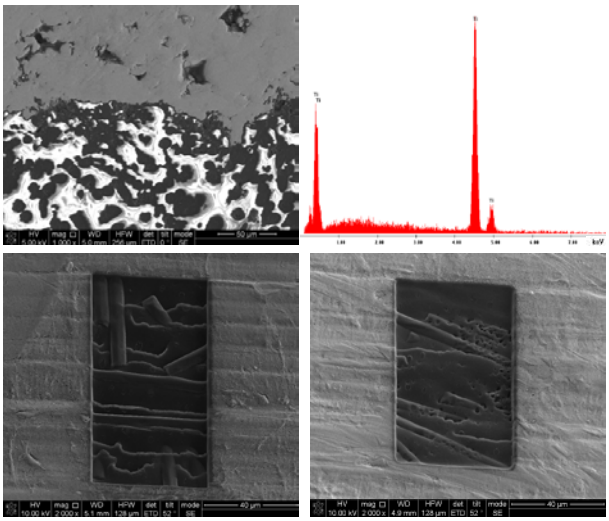

Fig. 1: Top: interface between coating and substrate (left), and EDX spectrum of VPS coating (right); down: fibre orientation after sandblasting (left) and coating (right).

Table 1. Crystallinity at different coating stages.

Sample (CFR PEEK)	Crystallinity [%]
Granule	31,9
Injection moulded	32,5
Sandblasted	38,5
Coated	29,4

DISCUSSION & CONCLUSIONS: Although it is demonstrated that good adhesion properties and coating morphology can be achieved, stress and thermal history at the basis of the VPS coating process may play a role in changing the CFR PEEK final properties. In fact, mechanical properties can be affected either by differences in fibre matrix adhesion or by a modified polymeric matrix, both induced by changes PEEK crystallinity. An optimal choice and/or tailoring of the coating process has therefore to be taken into consideration for the realization of highly durable orthopaedic components.

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