originated in the metal coating and then propagated into the substrate, decreasing specimens' fatigue limit. On the other hand, the carbon fibers have a toughening effect, strongly hindering crack propagation even in Ti-coated samples.

In conclusion, coatings can be successfully associated with PEEK substrate if a proper conservative design is used by considering working section reduction, elongation decrease, lowering of fatigue limit, and device strains in exercise. CFR-PEEK showed a more tolerant behavior when coated.

9.8 Summary and Conclusions

Surface functionalization of medical devices made of PEEK or CFR-PEEK is an essential requirement when a direct osteointegration between implants and host tissues is desired. Plasma spray coating was investigated as one potentially successful method for accomplishing this target. Among several available plasma spray technologies, VPS and air plasma spraying (APS) were shown to be suitable for osteoconductive materials apposition, although preserving substrate chemical–physical characteristics.

Titanium and hydroxyapatite are the most frequently applied materials for this purpose. For implant applications, Ti or HA coatings must succeed in reaching quantitative performances like controlled thickness and roughness, specific composition and porosity, adhesion and shear strength, fatigue endurance, abrasion resistance, and so on. Limits for coatings performance are given in ISO and ASTM standards as well as through FDA guidance if applied onto metallic substrates. However, with selected plasma spray process tuning and controlled analyses, such limits can also be successfully reached with PEEK substrates.

The Eurocoating experience was successful in reaching high adhesion values for HA and Ti coatings on several substrates made of PEEK or CFR-PEEK. Static mechanical characterization performed on coated samples confirmed that bulk strength is unaffected by coatings application. The fatigue limit at 1 million cycles for CFR-PEEK was unaffected as well. On the other hand, ductility and fatigue strength for neat PEEK are reduced after coating. Different failure behaviors of coatings are involved during fatigue cycling, depending on coating nature (HA or Ti), substrate (PEEK or CFR-PEEK), and strain values.

This chapter has summarized the performance and limitations of coating technologies for PEEK medical devices, so that implant designers can select the appropriate coating and substrate combination for a specific application. In vivo tests as well as preliminary clinical feedback thus far show promising results for pioneers currently in the market with coated PEEK devices.

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