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Abstract

Calcium phosphate (CaP)– titanium (Ti) composites were processed using a commercial laser engineered net shaping (LENS™) machine to increase wear resistance of articulating surfaces of load-bearing implants. Such composites could be used to cover the surface of titanium implants used in total arthroplasty procedures and potentially increase the lifetime of the joint replacement without any harmful metal ion release. It was hypothesized that adding calcium phosphate to commercially pure titanium (CP-Ti) and Ti6Al4V alloy via laser processing would decrease the material loss when subjected to wear. This added protection would be due to the *in situ* formation of a CaP tribofilm; which acts as a solid lubricant and a protective barrier. Different amounts of CaP were mixed by weight with pure titanium and Ti6Al4V in powder form. The mixed powders were then made into cylindrical samples using a commercial LENS™-750 system. Microstructures were observed and it was found the CaP had integrated into the titanium metal matrix, while causing the formation of columnar grains in the Ti6Al4V. Compression test revealed that CaP significantly increased the 0.2% offset yield strength as well as the ultimate compressive strength of CP-Ti. After conducting wear tests, it was found that the addition of CaP to pure titanium reduced the material loss and increased wear resistance. This was due to the formation of CaP tribofilm on the articulating surface. The *in situ* formed tribofilm also lowered the coefficient of friction and acted as a solid lubricant between the two interacting metal surfaces. Overall, CaP addition to Ti and its alloy Ti6Al4V is an effective way to minimize wear induced damage due to the formation of *in situ* tribofilm, a strategy that can be utilized in various biomedical devices.