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Simultaneous formation of carbide and boride layers on titanium by spark plasma sintering method

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Titanium materials have been widely used in the aerospace, automotive, and biomaterial engineering fields because of their high specific strength, superior fatigue and corrosion resistance, and excellent biocompatibility. However, titanium exhibits low hardness and poor wear resistance because of its high friction coefficient. Therefore, the development of a suitable surface modification technology is necessary to expand the use of titanium materials. Methods have been developed to coat the matrix surfaces of materials with a hard ceramic coating layer to improve their hardness and wear resistance. A diffusion coating method can be used to form a layer with superior adhesion with the matrix compared to coating layers formed using the PVD or CVD method, and the tribological properties and hardness of titanium have been reported to be improved by the formation of a hard layer. However, in conventional diffusion coating methods, the deterioration of the mechanical properties of the matrix resulting from long-term, high-temperature processing is problematic. Therefore, the spark plasma sintering (SPS) method, which features short processing times, can be used to form a ceramic layer. Moreover, composites composed of borides and carbides offer an attractive combination of excellent mechanical properties. However, the literature contains a few reports of surface modification via the SPS method using B4C powder. Thus, in this study, borides and carbides were simultaneous formed on titanium using the SPS method. Commercially pure titanium was used as a substrate, and the B4C powder was used as both a carburizing and boriding source. The X-ray diffraction pattern of the sample subjected to SPS processing indicated the formation of TiB2 and TiC. The corrosion resistance of the sample in a 2% HF-10% HNO3 aqueous solution was improved compared to that of untreated pure titanium because of the formation of a ceramic layer on the titanium substrate.

Keywords
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