Abstract:
Bulk commercially pure titanium was prepared by powder metallurgy, namely by cryogenic milling and spark plasma sintering, with aim to produce ultra-fine grained material with enhanced strength. The microstructure of milled powders was investigated in detail by a novel method called transmission EBSD, which allowed the first direct observation of texture within the powder particles. This texture is similar to rolling texture, because of the similar nature of the deformation during milling. Microstructure observations revealed grains with the size under 100 nm.

The influence of sintering parameters on material properties were studied by scanning electron microscopy including EBSD, X-ray diffraction and by microhardness measurements.

The trade-off relationship between porosity and grain size was identified, fully dense material with ultra-fine grained microstructure could not be produced. Increased oxygen content was identified as a main strengthening factor, while porosity has significant deteriorating effect on mechanical properties. The texture of powder was retained in the bulk material.

The possibility of stabilizing the microstructure by mechanical alloying of Ti with yttrium oxide nanoparticles was investigated with mixed results. The stabilization was successful, but several issues with the material preparation emerged, which must be further optimized.

Keywords:
titanium, cryogenic milling, spark plasma sintering, texture, transmission EBSD