The mechanical response and failure of Al-TiB_2 composites produced by Spark Plasma Sintering – A computational study validated by experiments

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ABSTRACT

Aluminium Matrix Composites (AMC's) are highly attractive structural materials due to their high strength to weight ratio. Theoretically, mechanical properties of AMC's can be tailor made to suit a specific application, by controlling the particle volume fraction, size and distribution. A good control of these parameters can be achieved using powder metallurgy [1].

In the present study, AMC specimens were fabricated by Spark Plasma Sintering (SPS) from a mixture of Aluminium and TiB_2 powders with 0-15% volume fraction of TiB_2. Compression of cylindrical and tapered specimens as well as Small Punch Test (SPT) experiments were conducted to examine the effective mechanical response and failure mode in both compression and biaxial tension loading modes.

Finite element (FE) analysis was used to investigate the relation between the microstructure and mechanical properties of the Al-TiB_2 composites. The effective flow stress was determined by an iterative computational-experimental process for each specimen composition. The FE models of the different configurations were also used to investigate the failure modes, using a continuum damage approach [2]. It will be demonstrated that the effective flow stress derived from the iterative process, which only considered the cylindrical specimens, is able to describe the mechanical response of the tapered and SPT specimens. It will also be shown that the continuum damage approach is able to describe the failure modes observed experimentally and that the effective fracture energy can be correlated to the particle volume fraction.

REFERENCES

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