Laser ablation of SiC_p/Al composite

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Abstract

Particulate reinforced metal matrix composites (PRMMCs) have been known for several decades. The combination of their outstanding properties such as strength and ductility makes them superior to many metal alloys. SiC_p/Al is one of the most promising PRMMCs for aerospace and automotive applications. However, SiC_p/Al is very difficult to machine with conventional methods due to the hard SiC particles. Specifically, machining of SiC_p/Al with conventional diamond tools always suffers surface damages and rapid tool wear, which compromises machining precision and increases costs. This paper involves a fundamental investigation on the precision machining of SiC_p/Al composite using nanosecond laser. The microstructure evolution and product during ablation was demonstrated by scanning electron microscopy (SEM) and X-ray diffraction (XRD), respectively. Based on the distinct morphology features, the ablated surface can be generally divided into three types, i.e. Al is ablated while SiC particles remain, Al reacts with SiC to form a homogeneous surface layer, and both Al and SiC particles are ablated. The homogeneous surface layer consisted of mullite ($3Al_2O_3 \cdot 2SiO_2$) and sillimanite ($Al_2O_3 \cdot SiO_2$), which resulted from the decomposition of SiC and the melting of Al. The effects of mullite and sillimanite on the final properties of the material and the ablation mechanism are discussed.