Novel Lightweight Aluminium Composites with Outstanding Mechanical Properties

HKUST | Reference: TTC.PA.0962 | Apr. 2019

Background

Despite the affordability of traditional materials used in industrial vehicles, such as hardened steels and aluminium alloys, there is a great demand for new, lighter and stronger materials with superior wear and corrosion resistance, damping and energy absorption capacity. When used in the bodies of dump trucks, for instance, such materials can increase the payload capacity and improve fuel efficiency. This invention delivers aluminium composites that possess the strength of steel while being 3 times lighter. On the other hand, the composites can have 20 times the impact absorption capacity of traditional aluminium foams, currently used in protecting cabin crew, battery modules, fuel and power supply systems from accidental impact.

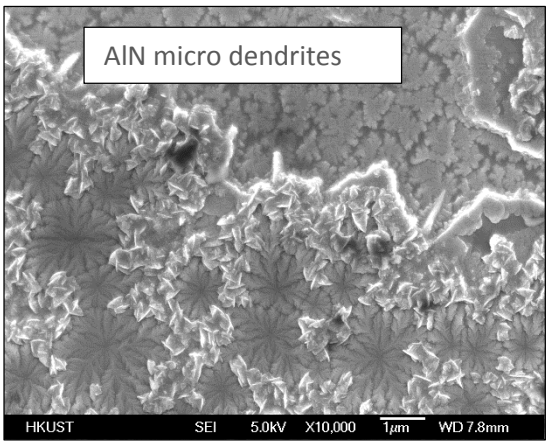
Technology Overview

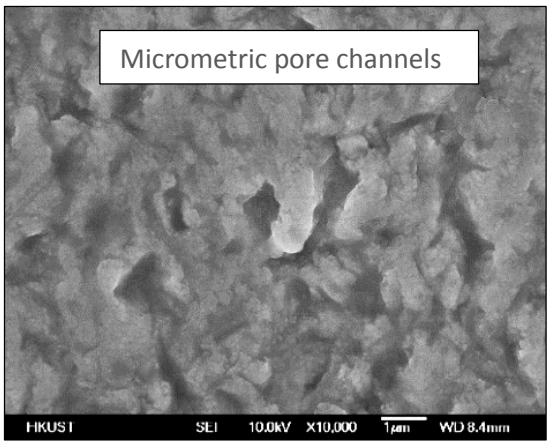
This innovative technology involves the rapid burning of aluminium powder in nitrogen gas with controlled processing parameters to produce porous Al composites. The exceptional strength of the composites is attributed to the increased growth of AlN micro dendrites in the porous structure, whilst the enhanced impact absorption capacity results from the myriad of nanometric pore channels. Our composites are affordable, as they are produced by the partial burning of fine aluminium flakes at moderate temperatures in a nitrogen atmosphere, the resulting composites also acquire exceptional fire resistance. They can be directly used as dump body parts, crash absorbers in land and aerial vehicles, bolt captures, emergency landing systems, micrometeoroid shields and blast mitigation. In addition, the material pores can be filled with phase change materials to store heat energy for room temperature control.

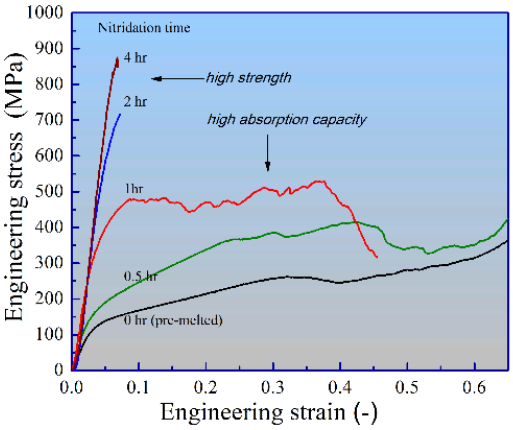
Benefits

- Mechanical properties of high-strength steels but 3 times higher
- 20 times the impact absorption capacity of conventional aluminium foams
- Resistant to corrosion and fire
- Straightforward and low-cost production
- Porous structure compatible with lubricants and phase change materials

Figures


AlN micro dendrites
HKUST SEI 5.0kV X10,000 1μm WD 7.8mm


Micrometric pore channels
HKUST SEI 10.0kV X10,000 1μm WD 8.4mm


Nitridation time
4 hr
high strength
2 hr
high absorption capacity
1hr
0.5 hr
0 hr (pre-melted)
Engineering stress (MPa)
Engineering strain (-)
0
100
200
300
400
500
600
700
800
900
1000
0.0
0.1
0.2
0.3
0.4
0.5
0.6