SYNTHESIS AND MECHANICAL BEHAVIOUR OF ALUMINIUM FOAMS

by

KUNWAR LAIQ AHMAD KHAN

Department of Applied Mechanics

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Dedicated

to

My (Late) Mother

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(Kunwar Laiq Ahmad Khan)

ABSTRACT

Aluminium foams of both types open-cell and closed-cell were synthesized by different routes. Closed-cell foam was synthesized by liquid metal foaming technique using TiH_2 as a foaming agent. The base metal chosen for foaming was AA2014 aluminium alloy owing to its better strength and ability to be heat treated. Open-cell aluminium foam was synthesized by solid state powder metallurgy route.

Three different ranges of strain rates were employed for compression testing of the closed-cell foam by using quasi-static testing (slow), drop hammer testing (intermediate) and split Hopkinson pressure bar (SHPB) testing (fast) and it was found that the plateau stress increases with the increase in relative density. The plateau stress of alloy foam in quasi-static compression at low strain rate of 10^{-3} s^{-1} is compared with existing theoretical and experimental results. The comparison shows that the present alloy foam have better compressive strength and better energy absorption capacities. The dynamic compression behaviour of alloy foam using drop hammer test at intermediate strain rate from 70 s^{-1} to 120 s^{-1} shows slight enhancement in the plateau stress and energy absorption capacity as compared to quasi-static compression. The dynamic compression test of alloy foam using SHPB at high strain rate of 700 s^{-1} shows very significant rise in plateau stress as compared to plateau stress found from quasi-static compression. The plateau stress obtained from dynamic test is compared with the existing results and found that the plateau stress matches well with the literature. The rise in plateau stress of present foam at high strain rate is due to

the strain rate sensitivity of the alloy foam. The present closed-cell alloy foam shows a bilinear behaviour at high relative densities. This bilinear behaviour shows that that at high strain rate the strain sensitivity of the metal increases.

The effect of precipitation hardening on AA2014 alloy foam is studied. The enhancement in plateau stress in precipitation hardened foam specimens is compared with existing results and found that the results are comparable with the literature.

Open-cell aluminium foams were characterized in compression tests and it was found that the plateau stress increases with the increase in relative density. The compressive strength of the open foams with different relative densities was compared with existing results of foams made by the same solid state powder metallurgy technique and was found to have higher compressive strength. The effect of alloying and addition of reinforcing phase on these foams was studied. It was observed that the addition of Mg as an alloying and SiC as a reinforcing element increase the compressive strength and energy absorption capacity of the foam.

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