

Dynamic behaviour of the 7075 high strength aluminium alloy produced by laser powder bed fusion (LPBF)

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High strength aluminium alloys of the 7000 series show unsurpassed strength-to-weight ratio and therefore attract much of the attention of the aerospace industry where lightweight design is paramount in material development. Despite a tendency to undergo hot cracking and elemental vaporization of Zn and Mg, the additive manufacturing of nearly fully dense parts of AA7075 by LPBF has proven successful in recent years thanks to the addition of grain refiners and a systematic process parameters optimisation [1].

At the dawn of the 21st century, it was becoming increasingly clear that materials did not behave in the same way under dynamic loading as they did under quasi-static conditions. The dynamic behaviour is here understood as how the stress evolves in function of the strain under high rate of deformation ($\dot{\epsilon} > 100 \text{ s}^{-1}$) [2]. This results in differences in strength, ductility, and toughness with strain rate and temperature. Although Ti6Al4V is quite covered in the literature and AlSi10Mg -even if controversial- is being studied as well [3], the dynamic characterisation of LPBFed high strength aluminium alloys is yet to be completed.

Concrete examples of applications where dynamic behaviour plays a role are numerous. We can cite the issue of turbojet engines where it is desirable to confine the turbine blades inside the enclosure in case of blade pull out; all cases of interactions of a projectile with its target; crashworthiness of vehicles; rock extraction by blasting in quarries; explosive welding; etc.

Using Split Hopkinson Pressure Bars (SHPB), the objective of this study is to compare the mechanical dynamic behaviour of the conventional wrought 7075 with the LPBFed 7075 from Zr-modified pre-alloyed powder, boosted in Zn and Mg to account for their vaporisation during processing. The build direction is known to have an influence on the microstructure and hence gives anisotropic mechanical (quasi-static) properties. This dependence on the build direction is also addressed but for high strain rates. Besides, two different thermal states (as fabricated and T6) are studied in the range $500\text{-}2500 \text{ s}^{-1}$, where strain rate hardening and thermal softening are in competition.

REFERENCES

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