Laser powder bed fusion in sub-atmospheric and high-pressure atmospheres

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An open-architecture laser powder bed fusion (PBF) system has been used for high-speed imaging of the process dynamics under different pressures and atmospheres. Experiments were carried out under sub-atmospheric, atmospheric and high-pressure conditions, and in argon and helium atmospheres. Long standoff microscopy results showed the motion of particles in the powder bed and schlieren imaging visualised the fluid dynamics of the inert atmosphere. Multiphysics modelling, validated by these experiments, has been carried out to understand the complex interactions between laser, metal powder and inert gas. These results provide useful information for process planning, regarding powder denudation, dynamic packing density, the production of metal vapour and spatter, and variations in laser absorption into the powder bed.