Laser powder bed fusion of tungsten-tantalum alloys and their acoustic properties

Seonghyun Park[1]

[1]Department of Mechanical Engineering, Stanford University, USA

Refractory metals, such as tungsten and tantalum, are defined as metals with melting points higher than that of iron (approximately 1600°C). Their exceptional combination of high density, strength, and corrosion resistance, even at elevated temperatures, makes them highly attractive for demanding applications in high-temperature industries such as aerospace and nuclear power. While metal additive manufacturing (MAM), also known as metal 3D printing, has recently been studied for the fabrication of refractory metals, most studies have reported the occurrence of cold cracking during the manufacturing processes. In this study, in-situ alloying of tungsten and tantalum using laser powder bed fusion MAM has been proposed to reduce crack densities. Various microstructural and mechanical properties of the tested samples were analyzed using optical microscopy, scanning electron microscopy, and electron-backscattered diffraction, as well as nanoindentations. Heat conduction-based thermal modeling was also employed to complement the above experimental results. Additionally, various acoustic properties, such as ultrasonic longitudinal and shear speeds, attenuation coefficients, and nonlinearity parameters, were measured using contact ultrasonic measurements in pulse-echo and through-transmission modes. The measured parameters were compared with those of other commercial metals. This study holds the potential for new applications, such as the production of ultrasonic sensors for extreme environments.