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Experimental study on the interaction mechanism between particles and plasma in plasma spheroidization

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Radio frequency (RF) thermal plasma is one of the most ideal methods for the spherical powders manufacture for 3D printing duo to its unique properties. To improve the perfomance of spherical powder, the changes of properties of plasma jets were investigated by the emission spectrometer before and after the precursor tungsten powders injected with the average size of 35.47μm, and the temperature, velocity and particle size of powders were monitored by the particle online monitor of DPV2000 at the same time. The electron temperature of plasma was calculated from the emission spectrum of ArⅡ spectral lines by Boltzmann plotted method, while its electron density by the Stark broading with the spectral line of Ar 696.54nm. The experimental results demonstrated that the intensity of emission specturm, electron temperature changed from 0.6ev to 0.2ev and density about $10^{15}cm^{-3}$ were both decreased after the injection of precursor tungsten powders.The temperature and velocity of tungsten particles in the plasma decreased with the increasing of axial distance away out of the plasma generator, and its average size of spherical tungsten powders was about 32.556μm. The spheroidization ratio of tungsten powders with plasma processing can reach up to 85% under that operating conditions in this study. It was also found that the thermodynamic process of tungsten powders in the plasma could be divided into three stages: melted, quenched and solidified. Those results can provide an experimental basis for the efficient preparation of spherical powders.

References

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Figures

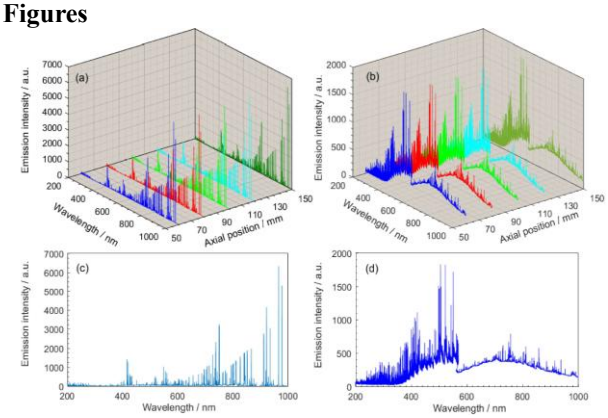

Fig.1 The emission spectrum intensity of plasma (a), (c) before and (b), (d) after the tungsten powders injection

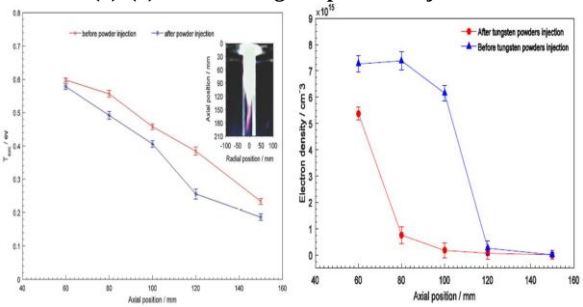

Fig.2 The electronic temperature and density of plasma at different axial position before and after the tungsten powders injection

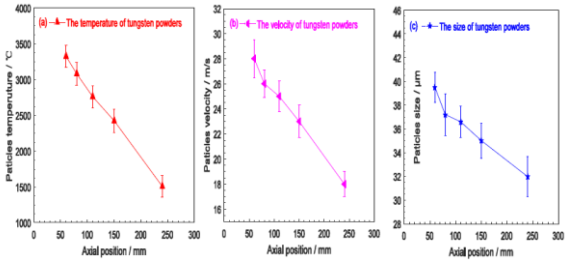

Fig.3 The temperature,velocity and size of tungsten particle at different axial position

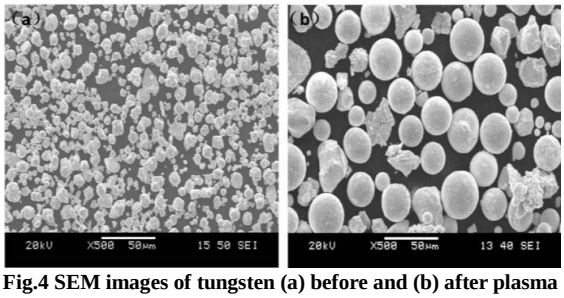

Fig.4 SEM images of tungsten (a) before and (b) after plasma spheroidization