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Simultaneous measurement system of temperature and velocity for thermal plasma spray droplets

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Thermal spray is an important technology for depositing coating layers on substrates to realize anti-corrosive and wear-resistant surfaces, enabling them longevity of various installations for energy and environmental systems. In particular, for the purpose of the corrosion prevention of large-scale infrastructures, such as steel bridges, the process control of the thermal plasma spray droplet deposition is important for yielding good qualities. In this poster presentation, the simultaneous measurement system of temperature and velocity for thermal plasma spray droplets, along with its results, are presented.

Figure 1 shows a schematic arrangement of the measurement system for temperature and velocity of plasma spray droplets. The plasma spray device used in this study was the Plazwire PW120 type, based on the wire plasma spray (manufactured by Plazwire Co.,Ltd), utilizing an aluminum-5% magnesium alloy JISH4040:A5056 (hereafter referred to as Al/5Mg) as the spray material. The distance from the gun exit is denoted as '*z*'.

In Fig. 1, the simple monitoring system is shown within a dotted line [1]. For the temperature measurement, the principle of the well-known 'two-colour' thermometry was used, where an intensity ratio at two wavelengths of a thermal emitter is compared with the Planck emission formula. For this purpose, the knowledge of emissivity of the thermal surface at the two wavelengths is necessary. For the velocity measurement, also the well-known 'time-of-flight (TOF)' technique was used, where a time delay Δt of a passage of an emitting body between well-defined positions having a distance of Δx is measured to yield the velocity $v=\xi\Delta x/\Delta t$, where ξ is a magnification or reduction ratio of a collection optics of an emitting body onto a recording surface [2].

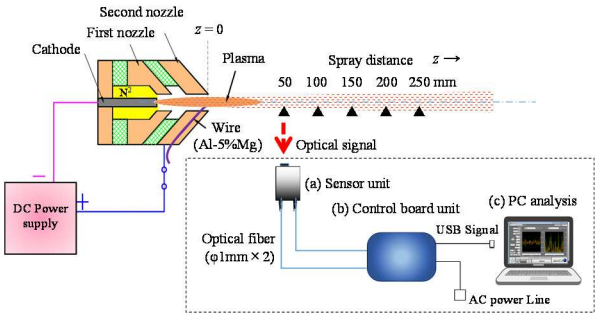

Fig. 1 Arrangement of the measurement system for temperature and velocity of wire plasma spray droplets.

Figure 2 shows the measured temperatures and velocities for plasma spray droplets of Al/5Mg wires. The temperature was about 2,800 K at *z*=150mm (the position where substrates are usually placed). The temperatures stay almost constant over the distances from the gun exit to *z*=250mm. The measured velocity was 70m/s at *z*=150mm. The velocities decreased sharply from the gun exit towards *z*=250mm.

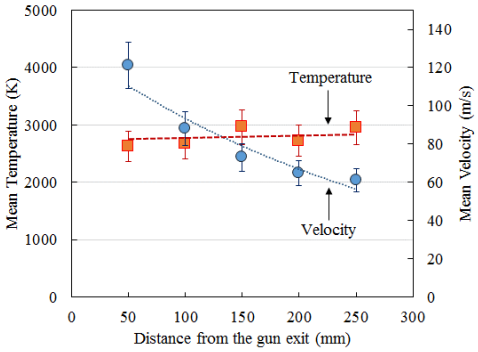

Fig. 2 Measured temperatures and velocities of plasma spray droplets of Al/5Mg wires.

Figure 3 shows the result of the curve-fitting of the measured spectroscopic data, obtained using an optical spectrometer (Ocean Optics, Flame-S, 600 grooves/mm, with a slit width of 25 μm), with Planck's formula for the temperature evaluation. This optical spectrometer was calibrated beforehand using a standard lamp (Gigahertz-Optik, BN-LH 250-BC, T = 3,380 ± 50 K) under a standard operating condition of DC 10.50 A and 22.24 V. From this result, along with the similar results at the different values of *z*, the accuracy of the measured temperatures by the above-mentioned simple monitoring system was independently confirmed.

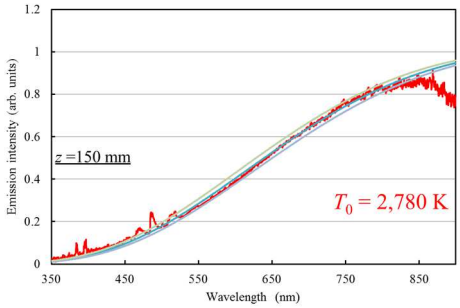

Fig. 3 A calibrated spectrum observed at z = 150 mm, and the fitting curves according to Plank's formula with an assumption of the spectral emissivity $\varepsilon(\lambda,T)$=const.

References

[1] Y Kawaguchi, *et al.*, 2015 JINST 10 C12011 DOI:10.1088/1748-0221/10/12/C12011
[2] Y Kawaguchi, *et al.*, *Coatings* 2017, 7(2), 27 DOI:10.3390/coatings7020027