Effect of DPV-2000 software parameter on the measurement result of in-flight particles in cold spray

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1. Introduction

The cold spray is a relatively recent coatings technology, where coating can be formed only the velocity of in-flight particles exceeds a critical velocity. Therefore, velocity is key factor to the cold spray [1]. DPV-2000 system is increasing used to detect the velocity, temperature and diameter of the in-flight particles. But few publications have reported the method to measure velocity and diameter using DPV-2000 in cold spray [2,3]. The effect of DPV-2000 software parameter on the measurement result of velocity and diameter in cold spray was discussed in the present paper.

2. DPV-2000 System and Theoretical Analysis

The measurement of temperature, velocity and diameter of in-flight particles by DPV-2000 was based on the thermal radiation emitted by the particles at a high temperature. However, the radiation intensity emitted by the cold spray particles is too weak to be detected by the optical sensor. A high-power solid-state laser, CPS-2000, was added to light DPV's measure volume. Velocity and diameter can be measured in cold spray by detecting monochromatic light scattered by the particles. Fig1 shows the schematic of the DPV-2000 used in cold spray [4].

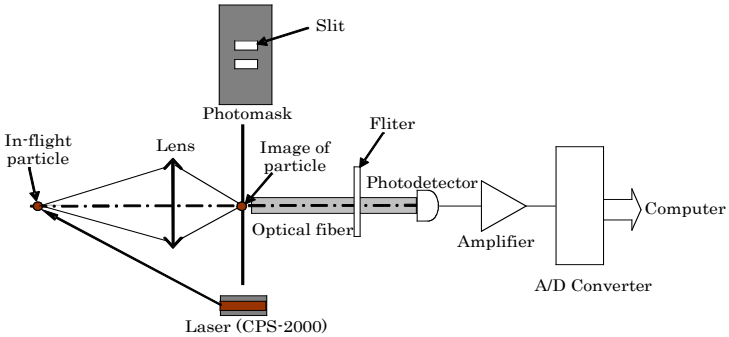

Fig1. Schematic of DPV-2000 system used in Cold Spray

When the images of particle fly through the two slits, a two-peak signal will be generated, as shown in Fig2. The particle velocity v is defined as

$$v = s/TOF \times \text{ Optical Magnification of the lens} \qquad (1)$$

Where TOF is the time of flight between the two slits, s the distance between the two slits. The diameter of a particle, D, is defined as

$$D = \sqrt{E}/\mathrm{DC} \qquad (2)$$

Where E is the energy of the signals, DC the diameter coefficient adjusted before measurement.

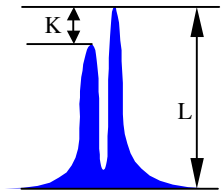

Fig2. Typical two-peak signal

Three typical software parameters were adjusted for accurately measurement, Trigger level, Laser power and Different peak height. Trigger level is a voltage threshold of the two-peak signals. Laser power is CPS-2000's power. Different peak height is a criterion to judge the signals good or not. Because some particles will not have perfectly trajectories through the two slits, the peak height of two-peak signal will not be totally similar, as the Fig2 showed. The criterion of Different Peak Height was defined as

K/L < Maximum Peak Height Difference (3)

3. Experimental procedures

For experiments, the cold spray system developed by Plasma Giken was used to spray the commercial Al powder (-45 μ m) shown as fig 3. A commercial Tecnar DPV-2000 and CPS-2000 system was utilized to measure the velocity and diameter of in-flight powder, altering one parameter of the three when the other parameters were constant.

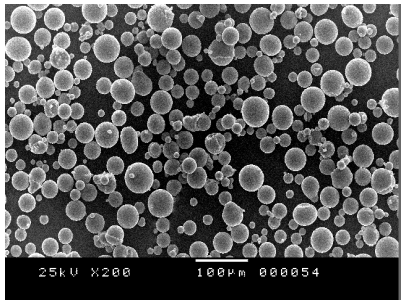

Fig3. SEM of the sprayed powder

4. Results and Discussions

Fig4 shows the amount of good signals (two-peak signals were regarded to emit by in-flight particles not noise by software) every 5 seconds, average velocity and average diameter as a function of the trigger voltage. When the trigger voltage was relatively low, the noise signals were received and confused to detect the good signals. While the trigger voltage was relatively high, the grain particles' signals weren't received because it was under trigger voltage. So the average diameter keeps

increasing when trigger voltage was larger than 800mv. The maximum amount of good particle was acquired when the trigger voltage is 800mv. While the trigger voltage has a little influence on the average velocity of the in-flight particles.

Fig5 shows the measurement results were affected by laser power. The amount of good signals and average velocity was increased with the increasing of laser power because the intensity of scatter by the particles was increased and more grain particles be measured. According to the Equ2, the average diameter was increased because the DC wasn't adjusted when the laser power increased.

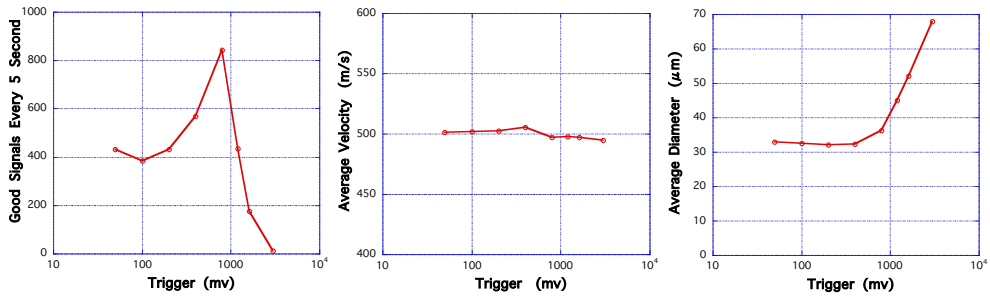

Fig4. Good signals amount, velocity and diameter as a function of the trigger voltage

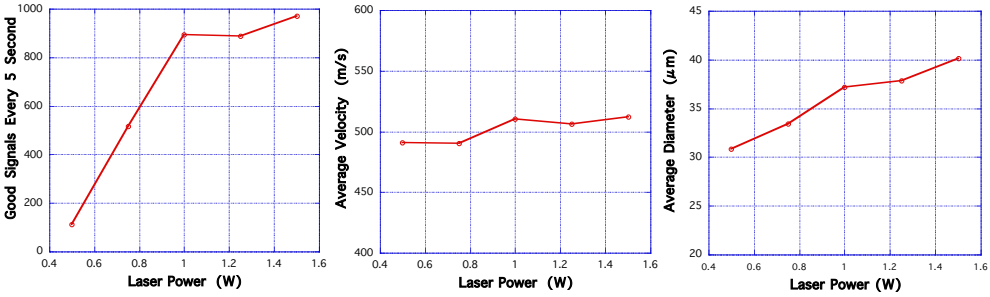

Fig5. Good signals amount, velocity and diameter as a function of the laser power

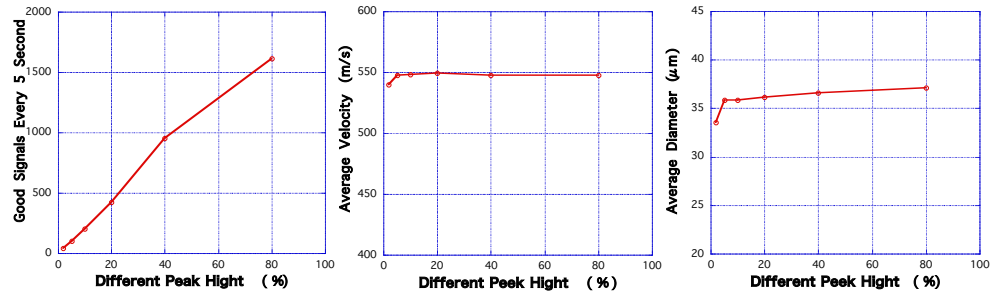

Fig6. Good signals amount, velocity and diameter as a function of the max different peak height

Fig6 shows the measurement results were affected by Max Different Peak Height. The amount of good signals was increased with the increasing of Max Different Peak Height because the tolerance of the criterion became wider and more signals were regard as good particles signals. The relatively low velocity and diameter when the value of Different Peak Height was at low level was resulted from the criterion being more strict, as a result, less good particles being detected.

5. Conclusion

The three soft parameter, trigger, laser power and different peak height, have relatively significant influence on the amount of good particles measured by DPV-2000 in cold spray. Sufficient amount of good particles is necessary to measurement accuracy. The measurement result of diameter was influenced by laser power. Therefore, it is essential to suitable adjust the DC when the laser power has changed.

6. Reference

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2) G. Bourque, M. Lamontagne, C. Moreau: A new sensor for on-line monitoring the temperature and velocity of thermal spray particles, ITSC2000, p45-50
3) E. Lugscheider, C. Herbst-Dederichs, L. Zhao: Particle behavior in a powder-laden HVOF jet, ITSC2000, p501-508
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