Phenomena during wire arc spray applications

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Résumé

The wire arc spray system is a widely used coating application tool offering high deposition rates at comparably low operational cost. An arc is ignited between two wire electrodes, which are constantly fed to compensate for the molten droplets detached from the tips by a strong perpendicular gas flow. Even though it is a commercially highly successful procedure, the investigations that have been reported on this method are still limited due to the highly complicated interactions between strong gas flows, changing electrode structures and reactive process gases. This paper aims at demonstrating some recent investigations into this technology to help understand the fundamental mechanisms as well as offering new diagnostic, which may be used to control the process to obtain higher quality and a better reproducibility.
High-speed imaging shows a constant motion of the arc between the electrodes in the direction of the gas flow with regular re-ignition at the narrowest distance between the two wire tips. Droplet detachments vary depending their origin from the anodic and cathodic electrode due to the differences in arc attachment and energy input leading to a bimodal primary particle distribution, which has been modelled in good agreement with experimental results.

The re-ignition between the wire tips may influence the primary particle production as the residence time of the arc attachment on the electrodes influences the particle production as well as metal vapor production, which in turn interacts with the movement of the attachments. It has been found that by using pulsed currents the re-ignition can be influenced significantly as long as it is close to the natural ignition frequency, which is approximately 1 kHz. The resulting behavior on primary particle production will be presented.
Due to the strong gas flow and thus the significant gas consumption for coating production, usually nitrogen or compressed air are used as the standard process gases. The use of air – cost-wise the preferred choice – leads to strong oxidation in the coating. This oxidation also depends on the process parameters. In order to obtain reliable information about the oxidation percentage the coating has to be analyzed post application by destructive methods. A new method has been developed to track oxidation during flight by using spectrally resolved emission data from the particles. By comparing temperature, independently of emissivity of the particles, with absolute intensity of the radiation, which is highly dependent on emissivity, the emissivity values of the sprayed particles can be determined. Using these data and comparing them with emissivity values posted in literature the oxidation can be determined non-destructively. The results of these investigations will be presented as well.

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