MEASUREMENT OF PLASMA AND PARTICLE VELOCITIES IN A THERMAL PLASMA JET BY CORRELATION AND PIV METHODS

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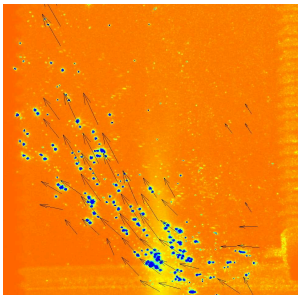
MOTIVATION

Distribution of particle velocities is an important parameter affecting the quality of coatings in plasma spraying technologies. In studies of the interaction between injected particles and plasma flow the knowledge of plasma velocity and temperature plays a decisive role. Particle velocities in the plasma jet area are mostly measured using laser methodologies, such as laser strobe, LDA and PDA methods. A recent PIV (particle image velocimetry) method used mainly in measurements of velocity distributions in "cold" flows seems to be a very perspective technique offering the advantage of a measurement range including the whole area of interest. Gas velocities in thermal plasma jets may be evaluated from optical emission fluctuations carried by the flow. The aim of this work was to test parallel application of these methods.

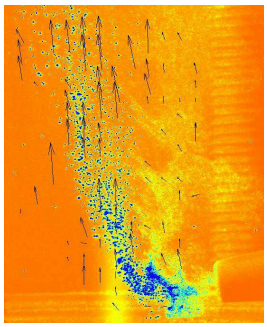
PARTICLE VELOCITIES

EXAMPLES OF PIV RESULTS

particles: corundum 69-80 μm, flow rate 80 slm



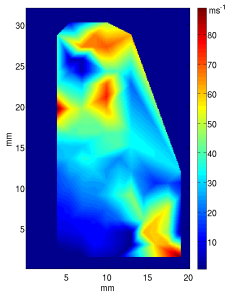
particles: corundum 25-32 μm, flow rate 80 slm



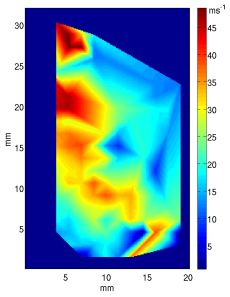
PARTICLE VELOCITY FIELDS (AXIAL COMPONENT)

particle sizes 69-80 μm

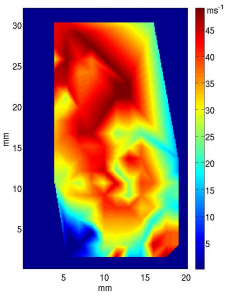
flow rate 20 slm



flow rate 50 slm

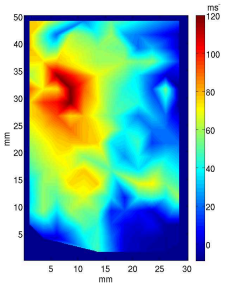


flow rate 80 slm

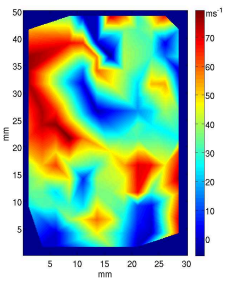


particle sizes 25-32 μm

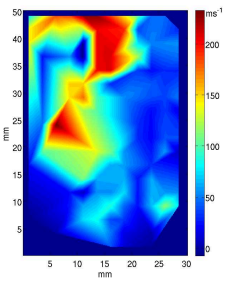
flow rate 30 slm



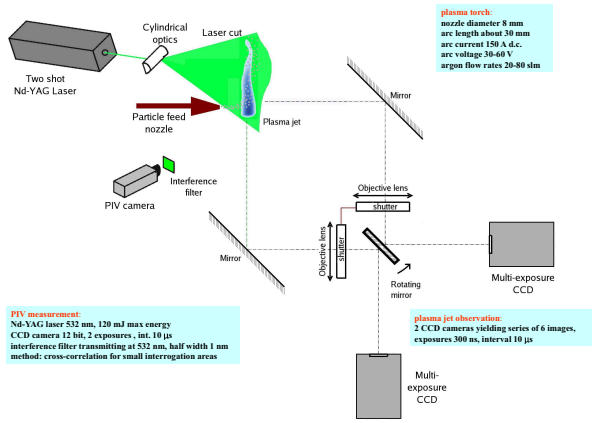
flow rate 50 slm



flow rate 80 slm

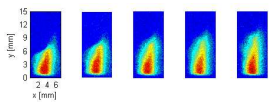


EXPERIMENTAL ARRANGEMENT

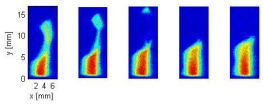


PLASMA VELOCITY

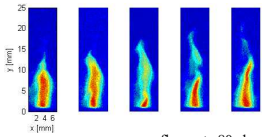
SERIES OF PLASMA JET IMAGES



flow rate 30 slm, interval 10 μs

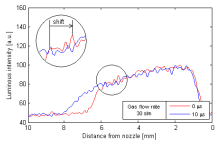


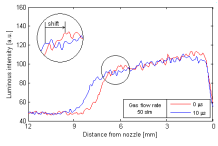
flow rate 50 slm, interval 10 μs

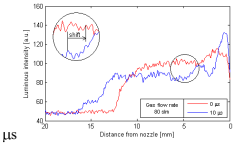


flow rate 80 slm, interval 10 μs

FLUCTUATIONS ALONG PLASMA JET AXIS







VELOCITY EVALUATION PROCEDURE

The method was based on searching the maximal correlation between fluctuations of optical intensity along the axis in two successive pictures. The value of the corresponding shift and interval between the exposures determine the velocity.
We correlated sectors close to the nozzle with the size of

- 130px = 6.5 mm for flow 30slm
- 100px = 5 mm for flow 50slm
- 100px = 5 mm for flow 80slm

PLASMA VELOCITY AS FUNCTION OF GAS FLOW RATE

(evaluated from 50 correlation calculations for each gas flow)