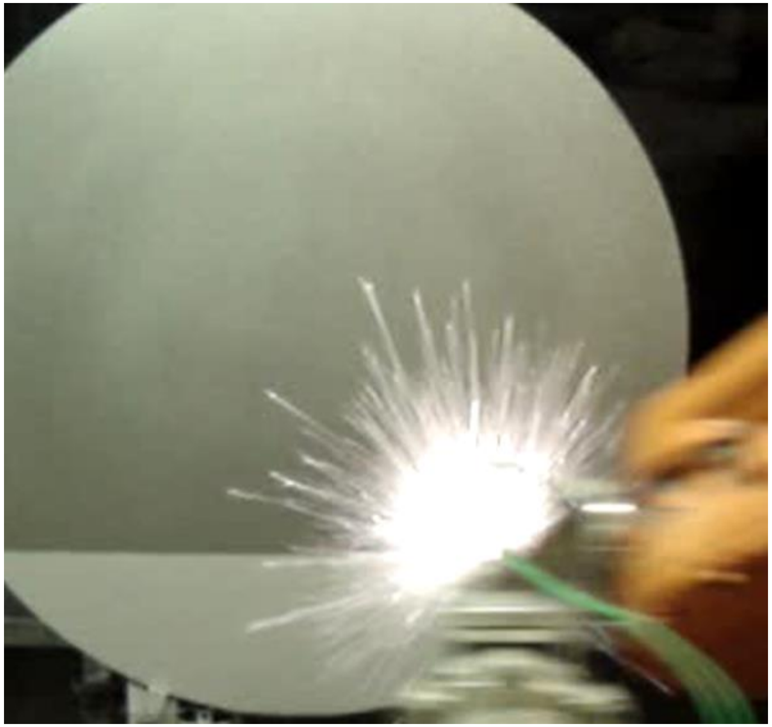
COLD SPRAYING IN MOTION



Video

COLD SPRAYING IN MOTION

• Velocity of particle	[m/s]
• Motion speed of the nozzle	[mm/s]
• Volume spray rate	[mm³/s]
• Area velocity	[mm²/s]

• Thickness	[mm]
• Feedrate	[g/s]
• Spot diameter	[mm]
• …	

E_{kin} vs. Temperature

Formula: Kinetic Energy → $E_{kin} = \frac{1}{2} m v^2$

Formula: Thermal Energy → $E_{th} = cmT$

Formula: E_{kin} vs. dT → $dT = \frac{1}{2} \frac{v^2}{c}$

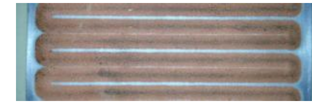
Temperature equivalent of velocity:

Copper v_{opt} 600 $\frac{m}{s}$ → $c_{Cu} = 385 \frac{J}{Kg\,K}$ → dT = 385°

Tantalum v_{opt} 575 $\frac{m}{s}$ → $c_{Ta} = 140 \frac{J}{Kg\,K}$ → dT = 1180°

Aluminum v_{opt} 650 $\frac{m}{s}$ → $c_{Al} = 897 \frac{J}{Kg\,K}$ → dT = 235°

Spraying a line

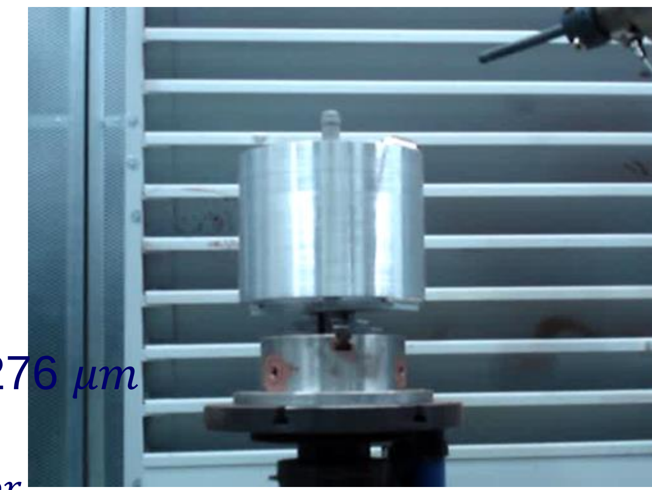


$$\left. {\left. {Volume\ spray\ rate} \middle/ {Motion\ Speed} \right.} \middle/ {Spot\ diameter} \right. = line\ thickness$$

Typical volume rate $\rightarrow 0{,}6\ \frac{dm^3}{h} \rightarrow 10\ \frac{cm^3}{min} \rightarrow 166\ \frac{mm^3}{s}$

Typical Motion Speed 200 to 1000 $\frac{mm}{s}$

Spot Diameter 2 to 10 mm



Example for 6 mm diameter spray spot:

200 $\frac{mm}{s}$ and 166 $\frac{mm^3}{s} \rightarrow 138\ \mu m \xrightarrow{shape\ factor} 276\ \mu m$

Example for 6 mm diameter spray spot:

1000 $\frac{mm}{s}$ and 166 $\frac{mm^3}{s} \rightarrow 27.6\ \mu m \xrightarrow{shape\ factor} 55.2\ \mu m$

Example for 6 mm diameter spray spot:

3000 $\frac{mm}{s}$ and 166 $\frac{mm^3}{s} \rightarrow 9.22\ \mu m \xrightarrow{shape\ factor} 18.44\ \mu m$

Spraying a line 2

Facts

1. „Motion Speed“ has an effect on the sprayed line
2. There is a velocity where the „optimum“ is reached
3. This velocity can be calculated
4. Higher velocities will not change the coating – lower will!

Spraying a single pass

$$\text{Volume spray rate}/\text{Area velocity} = \text{thickness of single pass}$$

Typical volume rate $\rightarrow 0{,}6\,\frac{dm^3}{h} \rightarrow 10\,\frac{cm^3}{min} \rightarrow 166\,\frac{mm^3}{s}$

$$Area\ Velocity\ =\ Motion\ Speed\ x\ Step\ size$$

Typical Area Velocity $\rightarrow$ 1000 $\frac{mm}{s} * 1\,mm$ = 1000 $\frac{mm^2}{s}$

Example for spraying a single pass:

$$166\ \frac{mm^3}{s}\Big/1000\,\frac{mm^2}{s} = 166\mu m$$

Spraying a thick coating

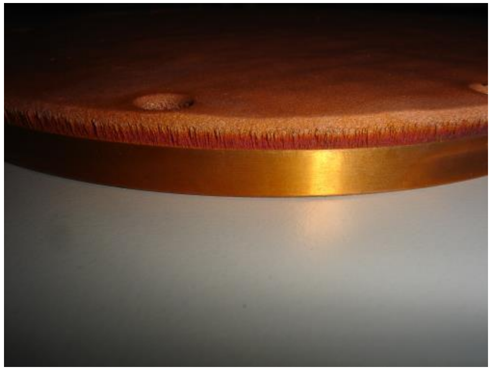
$$thickness\ of\ single\ pass * number\ of\ passes = thickness\ of\ coating$$

Example:

$1\ mm\ thick\ coating\ on\ 50\ x\ 50\ x\ 10\ mm\ aluminum\ sample$

$$Time\ to\ spray\ =\ volume\ of\ coating\ /\ volume\ spray\ rate\ (*\ overspray\ factor)$$

$$time_{spray}\ =\ 2500mm^3/166\frac{mm^3}{s} * 3\ = 45s$$



$Energy\ IMPACT\ on\ Sample$
$E_{kin} = 4014\ Joul$
$dT_{sample} = 58^{\circ}$