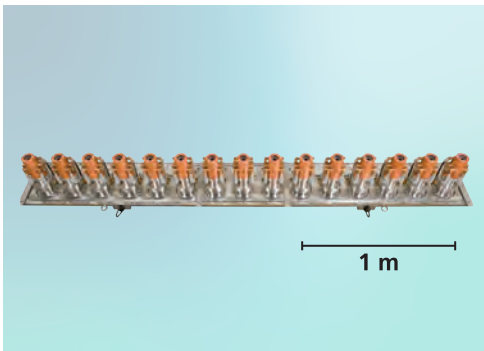


# Plasma-activated high-rate deposition

*Hollow cathode arc-activated deposition  
(HAD) by electron beam evaporation*



*Array of hollow cathodes*

Economic vacuum processes for the coating of large areas are required by almost all industry sectors. However, high coating rates, especially for high-rate deposition processes, lead to columnar layer structures. Even for the formation of chemical compounds during a reactive evaporation process, the energies of the vapor particles are often insufficient for stoichiometric deposition of oxide, nitride and carbide layers.

A suitable way of increasing the energy of the particles and thus reactivity and layer density is plasma activation during the deposition. High-power sources for dense plasmas, which allow a high coating rate and the coating of large areas, are required for this. Processes giving high-rate deposition with differently guided arc discharges have been developed at Fraunhofer FEP: spotless arc-activated deposition (SAD) and hollow cathode arc-activated deposition (HAD).

With these processes layers of good quality and dense structure can be efficiently applied to large areas of almost all substrates, such as sheets and strips of metal, glass or polymers, as well as to three-dimensional objects.

Plasma-activated high-rate deposition processes are especially interesting for applications in solar energy, mechanical engineering, packaging, environment and energy.

## Contact

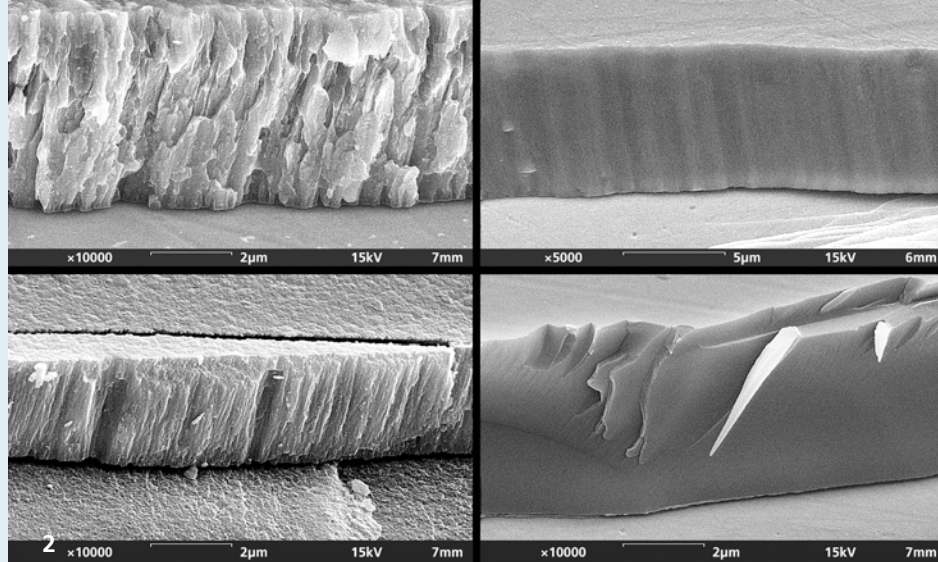
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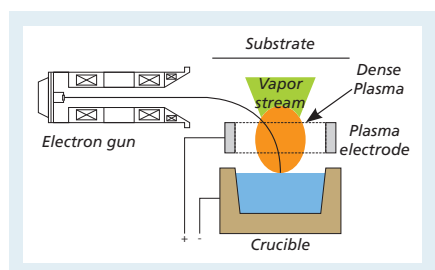
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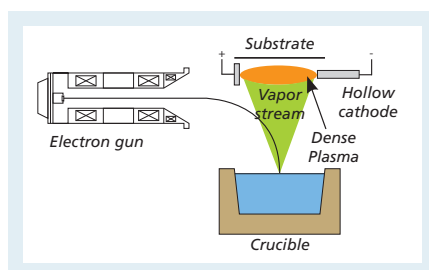


## Technologies

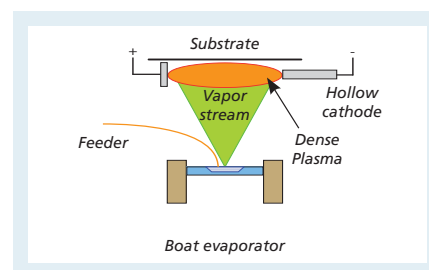
The technology can be applied with either electron beam evaporation or with different kinds of thermal evaporation. For plasma activation powerful guided arc discharges are available (SAD and HAD processes).



*Spotless arc-activated deposition (SAD) by electron beam evaporation*



*Hollow cathode arc-activated deposition (HAD) by electron beam evaporation*



*Hollow cathode arc-activated deposition (HAD) by thermal evaporation*

## Applications

- Corrosion resistant layers
- Decorative coatings
- Abrasion resistant coatings
- Transparent or chromatic protective films
- Hard coatings
- High refractive index coatings
- Transparent or metallic barrier coatings
- Insulating coatings
- Conductive coatings
- Photocatalytic TiO<sub>2</sub> layers
- Semiconductor layers for photovoltaics
- Special functional layers

## Typical coatings

### HAD process:

Al and Al alloys, Al<sub>2</sub>O<sub>3</sub>, a-C, Cr, CrN, Cu, CIGS, Si, SiO<sub>2</sub>, SiO<sub>x</sub>, SiO<sub>x</sub>-C:H, TiN, TiO<sub>2</sub>, Ti-C:H, ZnO:Al, CdS, CdTe, LiPON, YSZ

### SAD process:

Cr, Mo, Ta, Ti, TiN, TiAlN, TiO<sub>2</sub>, TiC, W, WC, Y, Y alloys, Zr, ZrO<sub>2</sub>, ZrN

## Process features

- Well suited for high-rate evaporation for large areas
- High potential for low-cost coating
- Enhanced layer properties
  - dense microstructure
  - smooth surface
  - compound layers possible due to increased reactivity in the process
  - high hardness
- Combination of PVD and PECVD processes
- Organic modification of PVD coatings possible

## Technical specifications\*

Evaporation power: 3 ... 300 kW  
 Plasma activation: 4 ... 40 kW  
 Deposition rate: 20 ... 3000 nm/s  
 Vapor ionisation: up to 60%  
 Deposition width: 200 ... 2800 mm  
 Layer homogeneity: ± 3 ... 30 %

\* all data depending on layer material, layer requirements and special technical design, not all combinations possible

## Our offer

Fraunhofer FEP has full in-house capability to take a project from concept to final industrial realization, including hardware and process development.

- Development of coating processes and layer systems for your products
- Feasibility studies and pilot production
- Development and supply of key components (vaporizers, plasma sources)
- In-situ quality control and process automation
- Equipment and operator know-how for plasma-activated deposition processes

### 1 SAD process

### 2 Titanium coating (top),

Al<sub>2</sub>O<sub>3</sub> coating (bottom) without / with plasma-activation (left / right)