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# Sealing of thermally sprayed coatings

Technical Bulletin DVS 2310

**Inhalt:**



## 1. Scope

This technical bulletin contains information on potential sealants, processing methods and notes on the selection and development of a functional sealing concept for thermally sprayed coatings. Studying this technical bulletin will enable the user to ascertain all variables relevant to the sealing task, check their suitability using the described test methods and put the findings to practical use, in accordance with the individual requirements profile.

## 2. Introduction

The term sealing refers to a method of applying and infiltrating porous surfaces with viscous substances, with the aim of achieving the complete proofing of the component against penetration by external media. Unlike thin and thick film processes, sealing does not aim to produce any measurable surface layer. In the case of atmospheric corrosion protection with thermally sprayed zinc or aluminium protective layers, without subsequent mechanical processing, the wet film thickness should be chosen so that the dry film thickness does not exceed 40 µm.

Depending on the process, thermally sprayed coatings often have open porosity, which extends as far as the base material. With sealing, application-specific advantages can be achieved in terms of durability and functionality. Sealing is carried out immediately after spraying, before machining to final size.

Sealing belongs to the group of chemical post-treatment methods. Because the method can be used on any material and the sprayed coating is sealed without undergoing structural change, it offers significant advantages compared with alternative thermal or mechanical methods (e.g. oxidation or surface compaction by shot peening). Among possible post-treatment methods, sealing is the most commonly used in the industrial environment.

Typical examples include corrosion protection, electrical insulation, increasing impact resistance and applications with alternating pressures.

Sealing involves a range of interdisciplinary issues, as the specific properties of the sealing material, the sprayed coating and the application technique all affect one another, see Table 1.

**Table 1. Factors affecting the sealing process**

| Sealant | Processing | Sprayed coating |
|---|---|---|
| Wetting behaviour<br>Viscosity<br>Hardening mechanism<br>Pot life<br>Chemical resistance<br>Electrical conductivity<br>Resistance to hydraulic pressures | Dipping, spraying, painting<br>Normal, over- and under-pressure | Structural properties (roughness, porosity,layer thickness)<br>Material properties (wetting behaviour) |

The close link between the process parameters involved calls for a detailed prior analysis and coordination of these factors. This also applies to the compatibility of the sealant with the coating material and any subsequent organic coatings, as in the case of atmospheric corrosion protection for example.

Sealing of thermal spray coatings is carried out where open discontinuities in the layer structure cause an unacceptable reduction of performance.

## 3. Types of sealant

Sealants are characterised, in particular, by the fact that they are viscous at the time of application and usually harden and solidify in subsequent process stages. It is recommended to classify sealants depending on the material group they belong to and the setting mechanism. By adopting a combined approach, it is possible to make statements concerning the specific material properties and the behaviour during hardening. The choice depends on the application, which provides a framework for the required thermal, chemical and tribological resistance of the sealing materials. For the sealing process, the wetting angle relative to the coating material, the viscosity and shrinkage behaviour during setting are decisive.

Suitable substances can be found in all material groups. The sealing materials can be used in pure form or as a mixture (metallic or inorganic fillers in organic compounds).

The aim is usually that the sealing materials should set after infiltration. This produces a composite sealing layer with specific properties that differ from those of unsealed layers particularly in terms of the mechanical characteristics (impact resistance, wear behaviour).

A distinction is made between physically and chemically setting systems. Polymers in particular allow targeted variation of the setting mechanism. This allows very specific production requirements to be met.



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With chemically setting systems, hardening takes place through initiation of a chemical reaction. Physically setting systems harden due to a change in the aggregate state or through evaporation of solvent or dispersing agent.

Table 2 shows the possible setting methods for selected basic types of sealing material. The specific time and temperature parameters are themselves highly variable within a group and are therefore not valid in all cases. The manufacturer's specifications must always be observed.

The different setting variants have their advantages and disadvantages, some examples of which are shown in Table 3.

**Table 2. Selection of sealing materials and their setting mechanisms.**

| Sealant | | Physically setting | | | | Chemically setting | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 1 K | | | | 2 K |
| | | Containing solvent | Dispersion | Melting | Sol | Temperature | Metal ions (anaerob) | Aerob | Photocatalytic (UV) | Hardener |
| Artificial substances | Acrylate (PMMA) | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ |
| | Epoxy resin | ■ | | | | ■ | | | ■ | ■ |
| | Furan resin | | | | | | | | | ■ |
| | Melamine resin | | | | | ■ | | | | ■ |
| | Oils (synthetic) | | | | | | | | | |
| | Phenolic resin | ■ | ■ | | | ■ | | | | ■ |
| | MS polymer | | | | | | | ■ | | |
| | Polyester | | | ■ | | | | | | ■ |
| | Polyurethane | ■ | ■ | ■ | | | | ■ | ■ | ■ |
| | Polyvinyl chloride | ■ | ■ | ■ | | | | | | |
| | Bitumen | | | ■ | | | | | | |
| | Waxes | | | ■ | | | | | | |
| | Silicone | ■ | | | | ■ | | ■ | | ■ |
| Natural substances | Oils | | | | | | | ■ | | ■ |
| | Biopolymers | | | ■ | | | | | | ■ |
| | Fats/waxes | | | ■ | | | | | | |
| | Tars | | | ■ | | | | | | |
| Inorganic substances | Oxides | | ■ | | ■ | | | | | |
| | Phosphates | | ■ | | | | | | | |
| | Silicates | | ■ | | ■ | | | | | |
| Metallic | Pure metals | | ■ | ■ | | | | | | |
| | Alloys | | ■ | ■ | | | | | | |

**Table 3. Comparison of advantages (+) and disadvantages (–) of setting mechanisms.**

| Physically setting | Chemically setting |
|---|---|
| + Viscosity easy to adjust | + Low shrinkage |
| – Health implications of systems containing solvents | + Solvent-free |
| – High shrinkage | + Defined characteristics for all processing variants |
| – Melting usually requires high temperature | + Setting can be initiated in different ways |
| | – Substances sometimes hazardous to health |