

Replaces the 1st issue

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**1 Scope of validity**

The leaflet contains recommendations for the correct thermal spraying of metallic and non-metallic additives to workpieces made from metallic and non-metallic base materials. It also provides general information about occupational health & safety and environmental protection as well as information on possible applications and the testing of thermally sprayed coatings.

Other recommendations for the application of thermal spraying are listed in DIN EN 1661.

**2 Definition**

Thermal spraying encompasses processes for the production of layers and moulded bodies where the spray materials inside or outside of the spraying equipment are melted, melted away or fused and sprayed onto the prepared surfaces of workpieces. The surfaces are not fused in this case. To achieve specific layer properties the spray coating can also be thermally treated.

The thermal spraying definitions and terms are defined by DIN EN 657.

**Areas of application of thermal spraying**

Thermally sprayed coatings are used to improve the properties of workpieces and parts, for example in relation to wear, corrosion, tribological behaviour, thermal transition or insulation, electrical conductivity and insulation, surface appearance and/or to restore operability in new products and repairs. They also provide the preconditions of solderability for particular applications. Thermally sprayed coatings without additional thermal treatment differ from coatings which are applied using other processes (e.g. welding, soldering, physical and chemical coating processes).

Advantages of thermal spraying include:

- The workpieces to be coated are only heated slightly so as to avoid undesirable structural changes and warping. The exception to this are processes involving additional thermal treatment.
- Coatings can be applied irrespective of the size of the workpiece or component. Depending on the process, coating may take place at a fixed location or alternating location.
- Even complex components can be coated provided the appropriate design principles are followed. Details are specified in DIN EN 15520 and DVS 2308 (expiring).
- The untreated surface of sprayed coatings generally provides a good prepared surface for other technical measures (e.g. organic coatings).
- Depending on the spray material and process, different coating thicknesses can be applied, with 10 µm as the lower boundary.

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DVS, Technical Committee, Working Group „Thermal coating processes“

Examples of process-specific disadvantages:

- Micro-porosity of the sprayed coating
- Limited bond strength of the sprayed coating
- Sensitivity of certain sprayed coatings without additional thermal treatment to edge pressure, spot and linear loading and impact
- Microstructural and adhesive restrictions in complicated geometries and, for example, when applying internal coating to bodies with a low internal diameter (minimum internal diameter currently approx. 40 mm).

When used correctly, thermal spraying is an economical process in new products and repairs. Some information on the properties of sprayed coatings can be found in Section 12. Additional thermal treatment of the sprayed coating is usually not necessary (for exceptions, see Section 10).

**4 The thermal spraying process**

DIN EN 657 gives an overview of processes introduced or available on the market (classified acc. to energy carrier).

Depending on the process, thermal spraying can be partially mechanised, fully mechanised or automated. With partially mechanised spraying, part of the process which characterises the spraying procedure, for example the wire feed rate, is mechanised, whereas with fully mechanised spraying all processes which characterise the spraying procedure are mechanised. In the case of automatic spraying, all of the functions which characterise the spraying procedure, including all secondary activities (including change of workpieces), are mechanised and run automatically according to a program.

The most commonly used processes acc. to DIN EN 657 include:

- Flame spraying,
- Arc spraying and
- Plasma spraying.

Less frequently used processes and processes in development are listed and described in Section 4.5.

**4.1 Flame spraying**

Flame spraying is subdivided into the following process variants:

- Wire flame spraying (WFS)
- Powder flame spraying (PFS)
- High velocity oxygen fuel flame spraying (HVOF) and
- Gas detonation flame spraying / D-Gun spraying (DGS).

Solid wires, cored wires, rods and cords and fluxes are used as standardised spray materials. Flame spraying is suitable for finer materials where the melting point or melting range is below the flame temperature.

**4.1.1 Wire flame spraying**

During wire flame spraying, the spray material (wire, rod, cord) is fed to the middle of an oxy-fuel gas flame and is continuously melted here and then propelled onto the prepared workpiece surface with the aid of expanding combustion gases or an atomizing gas, e.g. compressed air (Figure 1). Acetylene, propane and hydrogen can be used as fuel gases. Compared to conventional equipment, the equipment for high-velocity oxy-fuel flame spraying with wire operates with increased gas pressures and an adapted nozzle system.

**4.1.2 Powder flame spraying**

During powder flame spraying, the powder spray material is fed to an oxy-fuel gas flame and is melted or fused and then propelled onto the prepared workpiece surface with the aid of expanding combustion gases. The powder particles are accelerated by the oxy-fuel gas flame. If necessary, an additional gas can also be blown into the flame (Figure 2). Acetylene, propane and hydrogen are for example used as fuel gases.

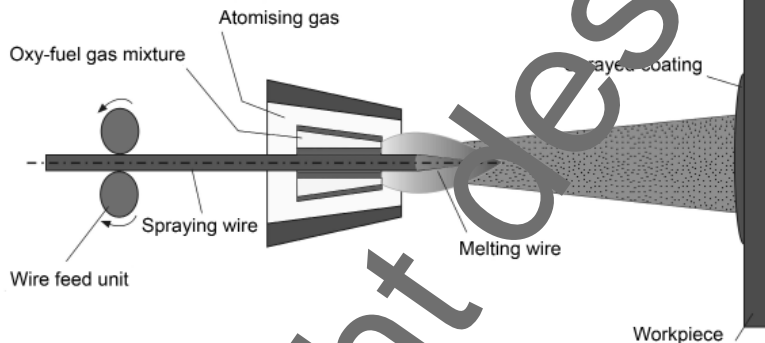


Figure 1. Schematic diagram of wire flame spraying.

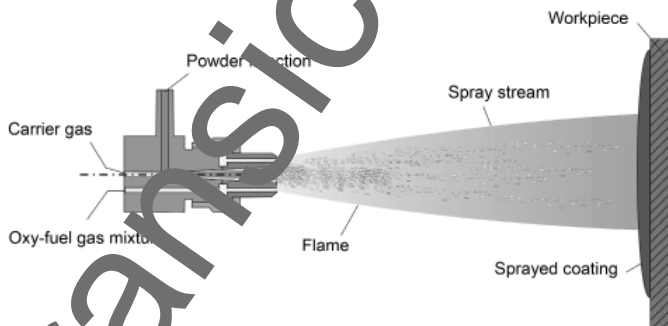


Figure 2. Schematic diagram of powder flame spraying.