

# Sol-gel process

Customised functional coatings for industry

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The sol-gel technique is an innovative process used to develop functional coatings with a relevance to all sectors.

Sol-gel is a simple and inexpensive deposition process which provides high mechanical strength making it an ideal solution for applying corrosion-preventive or wear-resistant layers to metals. It also offers a promising substitute to conventional surface treatments which are impacted by international regulations (Reach, Rohs, etc.).

## Context

- ▶ The emergence of new deposition methods has aided the fast development of surface engineering. These methods provide hydrophobic, conductive, insulating, antibacterial and many other functional properties. They constitute an alternative to costly vacuum deposition processes.

## Principle of the sol-gel process

- ▶ The sol-gel process is a wet chemical technique used for the fabrication of metal oxides (silica, alumina, zirconia, etc.). The liquid solutions are then formed based on various application methods, in particular as thin layers that are a few microns thick. Benefits of the process include the treatment of all types of substrates (metallic, inorganic or polymer). In addition, the operating conditions involved in the process are compatible with organic chemistry thereby opening up new opportunities for the creation of functional materials. This functionalisation can be conveyed by the treated surfaces.

There are four key stages involved in the fabrication of a sol-gel coating:

- the development/selection of the sol-gel formulation
- the nature of the substrate and the surface preparation
- the application process
- the curing treatment or densification

Moreover, as a general rule, all known paint and varnish application processes can be used to apply the sol-gel coating: spraying, dip coating, spin coating, laminar flow coating, brush, roller.

## Advantages of the sol-gel process

- ▶ Possible functional properties:
  - hydrophobic / hydrophilic
  - corrosion-preventive
  - scratch-resistant / wear-resistant
  - self-cleaning / smudge-resistant
  - anti-graffiti
  - antibacterial
  - colouring
  - primer

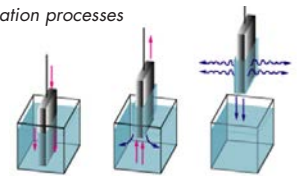
## Diverse characterisation methods

- thickness measurement
- assessment of adhesion properties
- electrochemical properties (barrier effect)
- accelerated ageing tests (salt spray, moist heat, etc.)
- assessment of mechanical properties
- assessment of mechanical properties (hardness, Young's modulus)
- optical and microscopic surface and sectional examinations



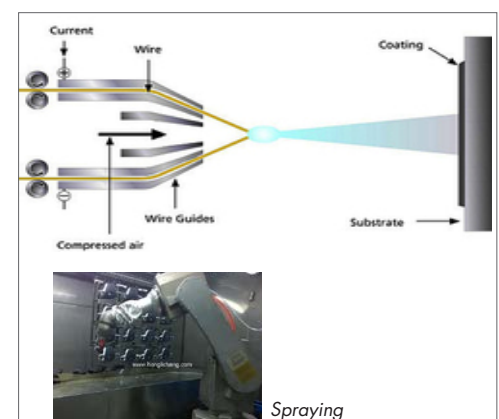
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Application processes



Dip coating

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Spraying

► Hydrophic / oleophobic surface



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*International Journal of Chemical Engineering and Applications, Vol. 2, No. 4,  
August 2011, Nanotechnology-A New Prospective in Organic Coating.*



© Extrait cahier technique Certech

*Compared transparency after one year of use for a standard glass and a self-cleaning glass.*

► Corrosion protection of a low-carbon steel after immersion in 60°C tap water



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*Bare steel after 4 hours*



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*Coated steel after 1,000 hours*

### **Industrial production process**

- Drafting of functional specifications with consideration of the regulatory and environmental impact as well as assessment of the technical-economical interest.
- Formulation of the sol-gel solution tailored to the various desired criteria and the relevant substrate(s)
- Determination of the best application process (processes)
- Characterisation and qualification of functional properties
- Creation of a prototype or a pilot prior to industrial production
- Implementation of an industrial line
- Qualification of the selected sol-gel solution and application process in accordance with the functional specifications
- Training of personnel

- A dedicated R&D laboratory
- Various application processes
- Physical-chemical characterisation techniques
- Pre-production pilot line

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