

ORGANIC-INORGANIC HYBRID COATINGS FOR CORROSION PROTECTION OF STEEL SUBSTRATES

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ABSTRACT

This paper presents a summary of the main research achievements in the development, through sol-gel method, of organic-inorganic hybrid coatings for protection of steel substrates against corrosion. A systematic selection of the most relevant contributions was made to give the best picture of the present consolidated know-how and perspectives to further development in this area.

KEYWORDS: Hybrid materials, Corrosion, Sol-gel, Coatings, Metallic substrates, Eco-friendly

Corrosion protection of steel components is usually performed using one or more of the following methods: 1) alloying metals with elements that enrich the surface with a corrosion-resistant component during the corrosion process; 2) addition of aqueous inhibitors, which adsorb strongly on the metal surface and prevent the reaction with the oxidizing agent; 3) deposition of protective coatings.

Carbon steel is used in large tonnages in marine applications. By their nature of limited alloying content, usually less than 2% by weight total addition, carbon steels are vulnerable to very high corrosion rates in aggressive atmospheres. In marine environmental, steel metallic corrosion process involves surface reactions of Cl⁻, O₂ and H₂O species, in addition to electron transport. The traditional surface passivation treatment for steel is conversion coating, which produces a layer of corrosion product capable of resisting further chemical attack. Phosphate conversion coatings (phosphating) have found use in the passivation of steel surfaces. Phosphate films have a good adherence, are somewhat porous and therefore form an excellent basis for paints, lacquers and rust-prevention oils and greases. The protective ability of the phosphate coating alone is, however, insufficient under corrosive conditions such as salt water contact.

Chromate conversion coating (chromating) is a process resembling phosphating and often used as a passivating treatment after phosphating. It is not used alone on steel. Chromating processes are rapid, cheap and easily carried out. However, current environmental regulations, which restrict the use of hexavalent chromium-containing compounds [1], have stimulated the design and preparation of anti-corrosion coatings using environmental-friendly materials.

Organic-inorganic hybrid (OIH) materials, synthesized by sol-gel processes, have attracted significant attention over the past decades as a new class of composite materials with innovative properties arising from the combination of organic polymer and inorganic materials.

Starting from a colloidal solution (sol), that acts as the precursor for an integrated network (or gel) of either discrete particles or network polymers, a large variety of chemical species, such as corrosion inhibitors, could be incorporated. The wide range of available chemical precursors for sol-gel process allows producing a diversity of inexpensive OIH coating materials at mild synthesis conditions. Furthermore, OIH materials could be produced by low-cost and high efficient common spray and dip coating methods which enhances the production of layers with adjusted chemical and physical properties that can be potentially used as eco-friendly corrosion protection systems.

This paper presents a summary of the research achievements, in the last decade, in the development of production, through sol-gel method, of hybrid protective thin coatings applied on steel substrates. It will also be made a comparison between the potentialities of this type of material with the existing methods currently available in the prevention of corrosion.

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REFERENCES

[1] European Council. RoHS, Directive 2002/95/EC, Restriction of the use of certain hazardous substances in electrical and electronic equipment (2003).