

Amorphous Coatings for Corrosion Protection in Demanding Environments

C. Warm, A. Winiwarter, N. F. J. Johansen, and S. N. B. Villadsen

DTU Mechanical Engineering, Technical University of Denmark

INTRODUCTION

Each year, corrosion inflicts damage resulting in costs between 3.1 and 3.5 % of a nations GDP [1]. Today, stainless steel is used in numerous places, including strongly corrosive environments e.g. chemical reactors. Stainless steel, however, is not necessarily well suited, with an expected lifetime down to 5-10 years in certain applications. Furthermore, with the restriction [2] on usage of hexavalent chromium the corrosion resistance of stainless steel is further troubled.

We therefore introduce a nano-engineered smart coating for metal substrates. This amorphous coating is tailored with transition metals to match the metal substrates, has excellent adhesion and superior corrosion resistance. Additionally, using an advanced after-treatment of the surface a dynamic self-cleaning mechanism can be added.

The coating can be used on cast iron, which has somewhat the same physical properties as stainless steel, not regarding the corrosion resistance, but is much cheaper. Standard stainless steel is at least twice as expensive as cast iron, but the prices of the more corrosive resistant alloys are far higher. Therefore additional the cost of a surface treatment can be tolerated while still keeping the price of the cast iron product competitive.

ENVIRONMENTAL IMPACT

The surface treatment we provide requires elevated temperatures in order to create the bonding, and thus the process requires a fair amount of electrical power. Comparing with other surface treatments, however, this process does not need a controlled atmosphere including toxic or rare gasses, and the pre- and after-treatment can be performed simultaneously with the same equipment.

The materials is used, which is made from different kinds of minerals, nothing toxic, and the pre- and after-treatments are performed using different kinds of salts. All these materials are found pure in nature and are only reactive at the elevated temperature the process works at, thus, completely safe for the customer.

As with glass-products, the surface treatment can be completely recycled [3]. This is a mayor advantage when comparing to other surface treatment; there is no other, which can be recycled! To remove the amorphous coating, only a simple metalworking process (rolling) is required.

In conclusion, this surface treatment is rather green, with only the rather large energy consumption during firing as a weak spot. The ovens used, however, run on electricity, and thus can be environmental-friendly as well. In production, the ovens could be set to work during night-time and therefore use the electricity generated by wind turbine at off-peak times. When taking into account the longer expected lifetime, the surface treatment must said to be green.

REFERENCES

- [1] <https://www.nace.org/uploadedFiles/Publications/ccsupp.pdf>
- [2] <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011L0065>
- [3] <http://www.gpi.org/recycling/glass-recycling-facts>