Flake-like nanoparticles offer reliable rust protection

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Flake-type nanoparticles of zinc-phosphate increase the gas barrier for corrosion protection in steel. Credit: INM/Uwe Bellhäuser

Large quantities of steel are used in architecture, bridge construction and ship-building. Structures of this type are intended to be long-lasting. Furthermore, even in the course of many years, they must not lose any of their qualities regarding strength and safety. For this reason, the steel plates and girders used must have extensive and durable protection against corrosion. In particular, the steel is attacked by oxygen in the air, water vapor and salts. Nowadays, various techniques are used to prevent the corrosive substances from penetrating into the material. One common method is to create an anti-corrosion coating by applying layers of zinc-phosphate. Now, research scientists at INM – Leibniz Institute for New Materials developed a special type of zinc-phosphate nanoparticles. In contrast to conventional, spheroidal zinc-phosphate nanoparticles, the new nanoparticles are flake-like. They are ten times as long as they are thick. As a result of this anisotropy, the penetration of gas molecules into the metal is slowed down.

The developers will be demonstrating their results and the possibilities they offer at stand B46 in hall 2 at this year's Hanover Trade Fair as part of the leading trade show Research & Technology which takes place from 25th to 29th April.

"In first test coatings, we were able to demonstrate that the flake-type nanoparticles are deposited in layers on top of each other thus creating a wall-like structure," explained Carsten Becker-Willinger, Head of Nanomers at INM. "This means that the penetration of gas molecules through the protective coating is longer because they have to find their way through the ´cracks in the wall´". The result, he said, was that the corrosion process was much slower than with coatings with spheroidal nanoparticles where the gas molecules can find their way through the protective coating to the metal much more quickly.

In further series of tests, the scientists were able to validate the effectiveness of the new nanoparticles. To do so, they immersed steel plates both in electrolyte solutions with spheroidal zinc-phosphate nanoparticles and with flake-type zinc-phosphate nanoparticles in each case. After just half a day, the steel plates in the electrolytes with spheroidal nanoparticles were showing signs of corrosion whereas the steel plates in the electrolytes with flake-type nanoparticles were still in perfect condition and shining, even after three days. The researchers created their particles using standard, commercially available zinc salts, phosphoric acid and an organic acid as a complexing agent. The more complexing agent they added, the more anisotropic the nanoparticles became.

INM conducts research and development to create new materials – for today, tomorrow and beyond. Chemists, physicists, biologists, materials scientists and engineers team up to focus on these essential questions: Which material properties are new, how can they be investigated and how can they be tailored for industrial applications in the future? Four research thrusts determine the current developments at INM: New materials for energy application, new concepts for medical surfaces, new surface materials for tribological systems and nano safety and nano bio. Research at INM is performed in three fields: Nanocomposite Technology, Interface Materials, and Bio Interfaces.

More information: Perre, Emilie, Albayrak, Sener, Wild, Mandy, Becker-Willinger, Carsten; "Flake-type zinc phosphate particles as new corrosion protection additives in organic coatings" Conference transcript of EUROCORR 2015, September 06-10, 2015, Graz, 2015

Provided by Leibniz Institute for New Materials

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