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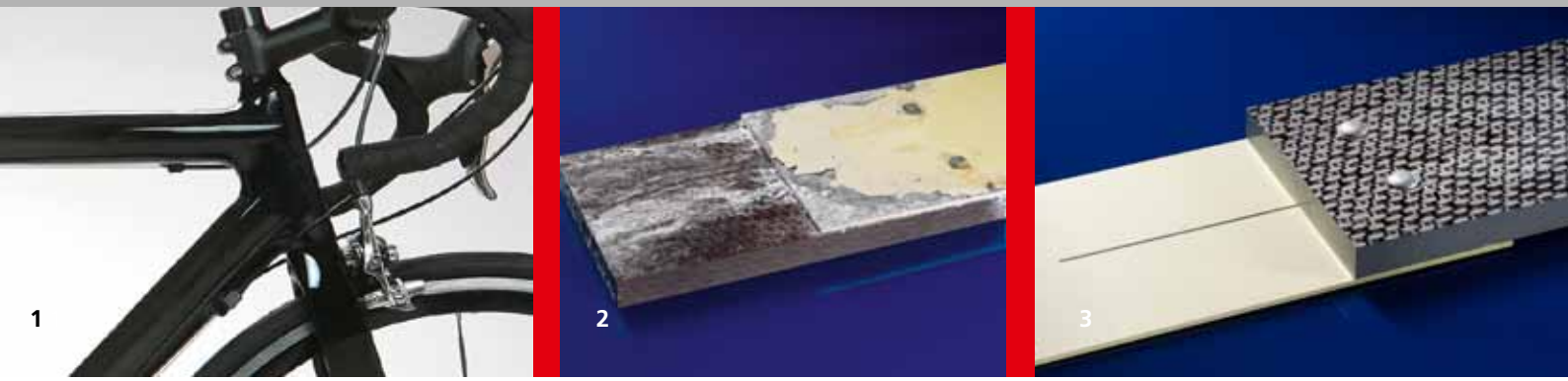

1 *CFRP-metal construction method.*
2 *Al-sheet with chromate-containing coating after 1000 h exposure to the salt-spray test.*
3 *Component with e-coat joined to an Al-sheet with Cr6+ coating, after 1000 h exposure to the salt-spray test.*

NEW CONCEPTS FOR CORROSION-PROOF HYBRID STRUCTURES MADE OF CARBON FIBER REINFORCED PLASTICS AND METALS

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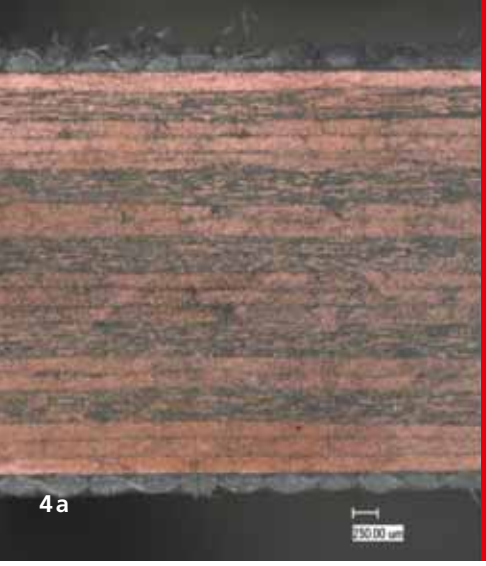
Background

The optimum solution for an innovative product is often to combine different materials. For lightweight structures, for example, the current trend is to use carbon fiber reinforced plastics (CFRPs) in combination with lightweight metals.
The CFRP elements can, however, establish galvanic corrosion of the metal partner. This is due to the electrical conductivity and very high electrochemical potential of the carbon fibres. The metal can lose its durability and the corrosion rate can drastically raise whith severe consequences.

Challenge

The problem is caused by the exposed fibers on CFRP elements. These exposed carbon fibers depend on the production method and processing steps but are almost always present. On electrical or electrolytic contact with metal elements, the corrosion process in the metal elements not only accelerates but also fundamentally changes. For example, the protective effect of corrosion inhibitors such as phosphates and chromates can be suspended.
The corrosion rate of the metal depends on the ratio of the surface area of the CFRP to the corroding metal surface (the so-called "surface area rule"). Protective coatings on the metal with small defects (which never can be avoided) can therefore cause very high corrosion rates.



Strategy

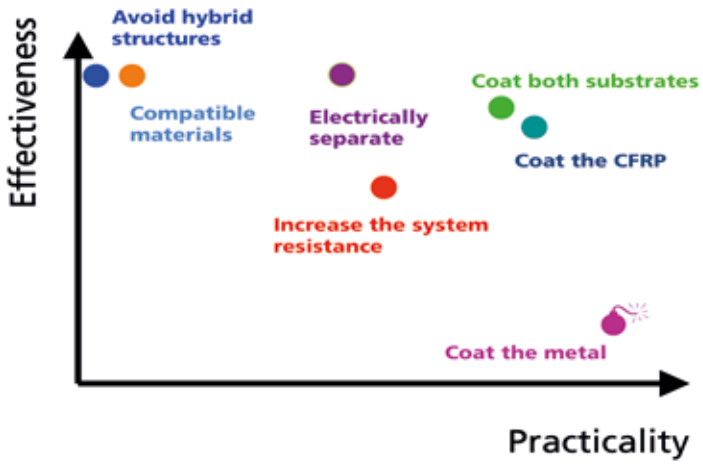
All strategies to prevent galvanic corrosion must take into account the technical boundary conditions and limitations. For example, interrupting the electrical contact and preventing electrolyte bridges etc. may seem wise from a theoretical standpoint but are often not technically feasible. Other measures may increase the risk of corrosion (coatings on the metal elements). The rules for corrosion-resistant design must be heeded for all new hybrid structures. Fraunhofer IFAM can provide you with expert advice on this matter.

A sound strategy is to suppress the electrochemical activity of the CFRP element. This can be done by, for example, applying suitable barrier layers to the CFRP. Electrophoretic coatings are ideal for this because the corrosion-triggering effect is utilized for the coating process and the free carbon fibers are covered very selectively.

Portfolio

Fraunhofer IFAM provides R&D services for all concerns in this area like:

- Advice on corrosion risks for hybrid structures
  - → Determination of corrosion-active areas
  - → Analysis and evaluation of real corrosion scenarios
  - → Identification of critical regions
- Evaluation of hybrid structure designs
- Development of proposals for customized corrective and protective measures
- Testing and evaluation of the effectiveness of protective measures
- Development of new protective measures, for example development of protective coatings



4a-c *Examples of exposed carbon fibers, marked via copper deposition*
a) cut edge,
b) after removing the peel-ply,
c) poor wetting.