Press information

High-Performance Coatings for Mass-Produced parts

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Corrosion and its consequences impair the safety, cost-effectiveness and durability of metallic structural components and workpieces. In Germany alone, the total cost of damage due to corrosion every year runs to billions of euro. For this reason, metallic mass-produced parts must be protected from corrosion. Although the commonly used methods of painting and electroplating using paint systems, powder coatings and electroplated coatings etc. reduce the corrosion process to a minimum, they are often not able to meet the significantly increased requirements for environmental compatibility, quality, stability and multifunctionality in total. Micro-layer corrosion protection systems (MKS) represent an innovative alternative.

The problem with coatings

When choosing a coating, the term "multifunctionality" is becoming increasingly important. As well as the main task of preventing corrosion, the coating systems which are being used are expected to satisfy numerous other requirements:

- Minimum thicknesses are required to make sure that the corrosion protection is sufficient.
- Maximum coating thicknesses must be maintained in order to ensure the function of the parts.
- The coatings must be resistant to chemical attack.
- Requirements also exist in regard to the decorative and characteristic appearance. Consequently, there is a large number of colours available on the coatings market.
- When parts are subjected to frictional loads, defined friction and slip properties have to be set.

For the designer and user, there is a bewildering number of coating possibilities which can only be checked working closely with specialist companies on a case-by-case basis. Dörken MKS-Systeme GmbH & Co. KG has been devoting its attention to micro-corrosion protection coatings for more than 20 years. As a rule, coating layers which are applied with thicknesses between 6 and 25 µm offer very long corrosion resistance times in the salt spray test. The company's product portfolio includes both zinc lamella coatings with tailor-made top coats and sealing systems for electroplate base coatings. Right from the beginning, these products have been free of known carcinogenic substances such as chromium (VI) and of course fulfil the other requirements of the "EU End-of-life Vehicles Directive". Currently, a huge number of components such as connecting elements, stamped and bent parts, clips, springs, side-impact struts and brake discs are coated by experienced licensees using MKS systems.

Coating systems

In general, the coating systems consist of a base coat and an organic or inorganic top coat. However, a coating may consist of a base coat alone without a top coat, depending on requirements. Both the base coat and the top coat are stove systems which chemically crosslink at temperatures below 250 °C. The zinc lamella systems, DELTA PROTEKT® KL 100 and DELTA®-Tone 9000, are largely inorganic, micro layer forming base coats which are packed with zinc and aluminium lamellae. Because of their metallic nature, they provide cathodic corrosion protection. Since the layers of lamellae are laid down in the form of scales, they have a barrier effect which delays attack from corrosive media, such as moisture and oxygen, significantly more than conventional electroplate corrosion protection coatings. The corrosion protection can be considerably increased further by subsequently applying an organic top coat such as DELTA®- Seal or using silicate, water-based products from the DELTA-PROTEKT® VH 300 series.

Unlike the base coat, the top coat is not electrically conductive. Additional corrosion protection is provided by isolating the base coat from corrosive attack. Other requirements such as the colour, temperature stability, chemical resistance and defined slip and friction properties can be met depending on the choice of top coat.

However, an optimum corrosion protection can only be realised if the adhesion of the coating to the workpiece is very good. A prerequisite for good adhesion between the coating and the substrate is therefore a pre-treatment which is tailor-made for the part in question. Commonly

used methods are degreasing in hot alkaline solutions, blasting and fine crystalline zinc phosphating.

Coating technology

The choice of coating technology which is to be adopted is determined by the part to be coated. Zinc lamella coatings are applied by using application techniques which are commonly used in painting technology and then stoving them in continuous ovens after each coating process. In principle, there is no risk of hydrogen embrittlement in high-strength parts since they are not exposed to hydrogen during the coating process. The processes which are usually used to apply coatings to parts with complicated shapes are the spraying method, and for mass-production small parts the dip-centrifuge method. Loose parts are poured into a basket, immersed in a coating medium and then centrifuged to remove the excess material. This process takes place in enclosed coating plants. The required coating parameters, such as the immersion time, centrifugation time and angle of inclination of the plant, are controlled by computer.

In principle, the coating and stoving processes are carried out several times in order to guarantee the required material coating. Heavy parts which cannot be poured can be coated by using either the spin-coating method or spray applications. Both manual and automated robot techniques are used for spray applications.

Tribology

Connection elements are largely coated with MKS systems where the highest priorities are high corrosion protection and defined coefficients of friction with low scatter. Maintaining the coefficient of friction and minimising the scatter of coefficient of friction values on a threaded connection is essential for automated assembly. The importance of the coefficient of friction is clearly demonstrated by an example from practice. Wheel bolts are unscrewed and screwed in once during assembly and then at least twice every year thereafter.

When the wheel bolts are fitted, the torque setting is used as the control variable. A threaded connection is designated safe when a defined prestressing force is applied. In this case, safe means the threaded connection is solid. The prestressing force on the threaded connection is determined by the geometry and the strength class. When the wheel bolt is tightened using a torque wrench, the total torque which is applied is divided into the following components:

- The friction under the head of the bolt accounts for approximately 50 % of the total torque.
- The friction from the thread of the screwed connection accounts for approximately 35 %.
- Only 15 % of the applied torque is thus left to produce the required prestressing force.

If a lubricant which produces a low coefficient of friction is used in the coating, then a high pre-stressing force is achieved earlier, i.e. for a lower torque, than by using

lubricants which produce a high coefficient of friction. Therefore, when tightening the bolts to a specific torque, the frictional properties must be adjusted so that sufficient lubrication is always present. This point is even more important if the threaded connection is expected to be loosened and tightened several times.

On the other hand, the lubricants which are used must not lubricate the system so much that there is a risk of the connection working loose. This risk is present with coefficients of friction below $\mu = 0.06$ and, in the worst case, could lead to the loss of a wheel due to the wheel bolts working loose. In order to prevent this life-threatening situation from arising, car manufacturers recommend retightening wheel bolts to the specified torque setting approximately 50 km after each wheel change.

In the past, the coefficients of friction of threaded elements were usually adjusted by relubrication. This represents extra work which is costly both in time and money. Besides, relubrication does not always provide satisfactory grip. Coating systems which incorporate the lubricant in the top coat are therefore gaining in popularity on the market. This type of system, which incorporates the lubricant in the top coat, has the advantage of reducing the number of coatings which are necessary while ensuring absolute grip and resistance to ageing.

With the Dörken MKS systems, the coatings which have integrated lubricants and which can be used to adjust the coefficients of friction to a defined value are designated by the abbreviation "GZ" (slip additive). By using these coating systems, the corrosion resistances, various

coefficient of friction requirements and other requirements in the car industry can be satisfied consistently in-process.

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MKS-Systeme GmbH & Co. KG or one of its licensed job coaters will be pleased to answer questions concerning actual coating requirements and specifications. A list of job coaters and comprehensive information on the subject of micro-layer corrosion protection coating is available on the internet at www.doerken-mks.de