coatings

Editorial

Coatings in Industry Research Methods—A Short Review

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Coatings of various types are very willingly and widely used in all industries. Their tasks are varied. Most often, it comes down to protection against damage, including mechanical damage and corrosion [1,2], or it changes the nature of the physical contact of two cooperating parts by, for example, changing the coefficient of friction and the coefficient of abrasive wear [3,4].

Obtaining the desired features, however, requires an appropriate production process and is often preceded by a number of experimental studies [5]. Today's technology allows the use of a whole range of methods that enable different types of contact, in different planes and in different conditions [6].

Due to the degree of simplification, there are: tests on the object in real working conditions, tests on the object in simulated working conditions, tests on a sample or part of the object and model tests. Each of them, of course, has its advantages and disadvantages. The first one allows to obtain the best results, perfectly reflecting the actual conditions, but it is usually associated with high costs. It is also not always possible to perform such tests, e.g., for technical or ethical reasons. Testing an object in simulated conditions is much easier to implement. It allows us to place the test item under controlled conditions, and repeat the same conditions for subsequent trials. Therefore, it is used very willingly, from medical and veterinary sciences [7,8], through dynamic phenomena, e.g., crash tests [9], ending with machine components of all kinds [10,11] and their connections [12,13]. However, it may require the construction of a special, individual laboratory stand, which does not have a positive impact on the total cost of research. From the point of view of repeatability of results, the best tests are performed on a sample of the object. A decisive advantage of this method is also the possibility of making samples of any shape and size, which allows for standardized tests. The last of the methods presented above, the model method, allows us to perform tests without the need to access the test object [14,15]. It is usually performed using a computer and dedicated software. For this reason, this type of examination can be many times cheaper than those presented earlier. The problem, however, is the need to describe the studied phenomenon using mathematical equations [16]. This requires the use of a number of simplifications, which unfortunately causes a decrease in the quality of the obtained results, which finally differ from the real state.

Laboratory tests of coatings that are dedicated to mechanical contact can also be divided according to the type of contact. There can be point, line or surface contact.

The ball-cratering method can be used to test point contact. This is a method of abrasive microwear, dedicated primarily to thin coatings. Stands of this type, e.g., T20, allow testing both dry contact and in the presence of foreign substances. These substances can be both lubricants and abrasives. It is also possible to adjust the flow rate to suit individual needs. Such a test requires the determination of three input parameters: the friction distance, the rotational speed of the ball and the normal force. It is best to determine them in preliminary studies using, for example, the Taguchi process optimization method [17].

The study of linear contact, in turn, is very often carried out using the pin-on-disk or ball-on-disc method. Three parameters are also introduced to this type of research: friction distance, speed and contact pressure [18]. Some stations of this type also have the ability to adjust the radius on which the pin/ball slides.

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Anti-corrosion coatings (e.g., paints) are tested in a slightly different way. The most common methods are: the cross-cut method, the X-cut method and the tear-off method. The first one consists in making two cuts at a 90° angle with a special, multi-bladed knife. A tape with a certain adhesion is then applied to the test site and peeled off. The obtained trace is compared with the standard [19]. This allows us to determine the quality of the adhesive bond of the coating. However, this method has some limitations—the spacing of the blades does not allow for testing thick coatings. There are no such limitations in the X-cut method, in which a single-blade knife is used. The incision is made at an angle of about 60°. A tape is also glued to the test site, and then the obtained surface is compared with the standard.

However, not only the adhesion of the coating is important. Its internal strength—cohesion—is also of great importance. The peeling method can be used to test it. Unfortunately, it requires much more time and work than the previous two. This is mainly due to the fact that it is necessary to glue the stamps and fully dry the connection. Only after complete drying, you can proceed to the examination. First, using a trephine drill, the tested fragment is separated from the rest of the coating. Then, the stamp is torn off with a device that measures the value of the force at the time of tearing off. The appearance of the fracture allows us to assess both the adhesion of individual layers of the coating, as well as cohesion [20].

Unfortunately, all the methods presented above, with the exception of model tests, are destructive tests. However, their performance is necessary to obtain the highest possible quality of the coating. The tests also help in determining the correct application or production procedures (depending on the type of coating).

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