Faculty of Science and Informatics Department of Physical Chemistry and Materials Science 6720 Szeged, Rerrich Béla tér 1. Tel: (62) 544-209 / Fax: (62) 544-042

Abrasive tests

Investigation of the stability of composite films

Composite films were made from the available antibacterial coating material by spray film formation technique. During this process, a uniform 3 mL of suspension was applied to 5 x 10 cm 2 hydrophobic (polypropylene film) surfaces. For comparison, thin layers were also formed on the surface of a glass carrier by spraying 3 mL of polymer and photocatalyst / polymer suspensions onto the surface of a 5 x 10 cm2 glass. The stability of the prepared films was tested by performing abrasion tests. For the experiment, we used a hand-operated Crockmeter (Fig. 1), which is ideal for testing the abrasion resistance of various surfaces, for example, in the textile industry, for testing the color durability of textiles. The device has a 9 N downward pressure force, a manually operated crank, a speed counter.

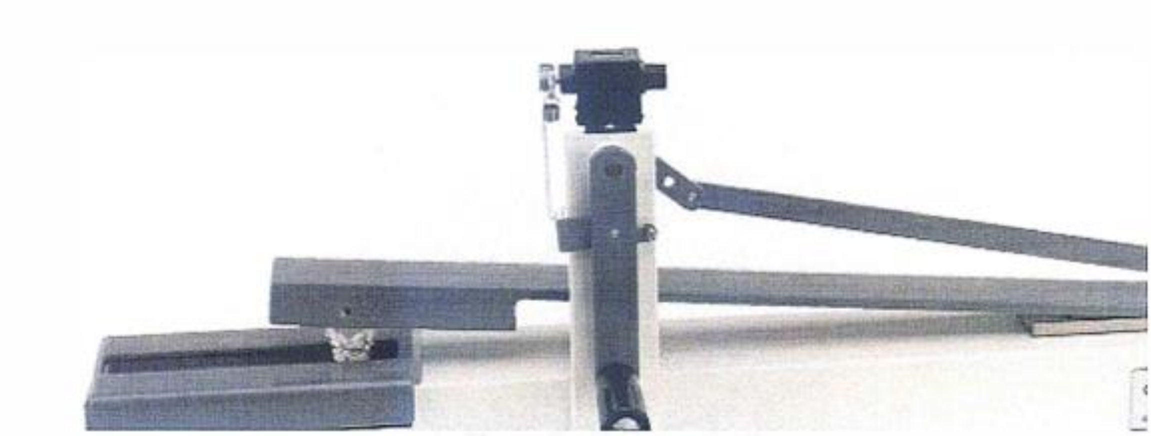

Figure 1. Photo of a crockmeter.

Figures 2 and 3 show the stability of the starting polymer layer after 5, 10, 25 and 50 abrasion cycles. The stability of the polymer layer on the surface of both foil (Fig. 2) and glass substrate (Fig. 3) was examined. The photos show that after the initial abrasion cycle, the layer suffers damage to both the film and the glass substrate, the extent of which increases with increasing number of abrasion cycles.

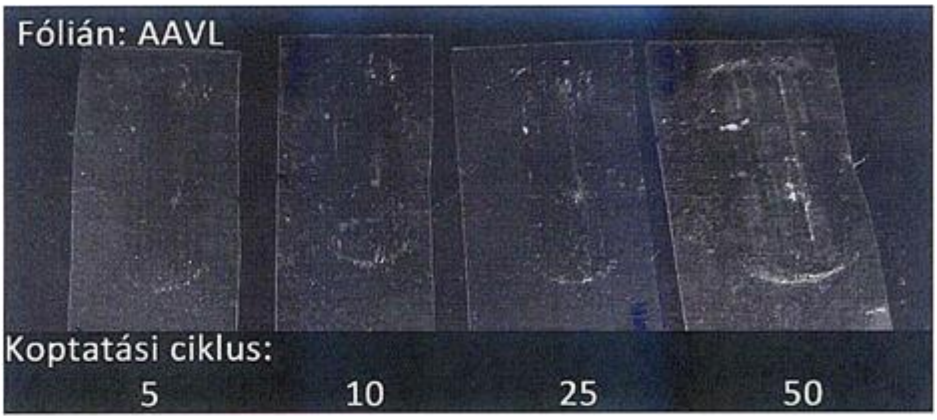

Figure 2. Photograph of films formed on the film-carrier polymer (AAVL) after 5, 10, 25, and 50 abrasion cycles.

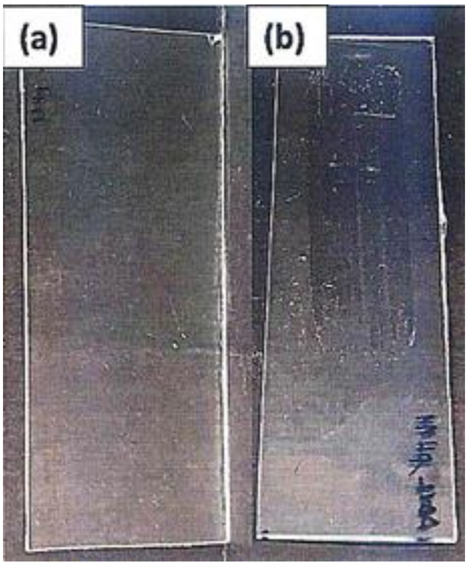

Figure 3. Photograph of the polymer film after the initial (a) and 50 abrasion cycles formed on the glass substrate.

Figures 4 and 5 show photos of TiO2 / ZnO / polymer composite films after 0, 5, 10, 25, and 50 wear cycles. In composite films, the catalyst / polymer is present in 50-50% m/m on the surface of the carriers.

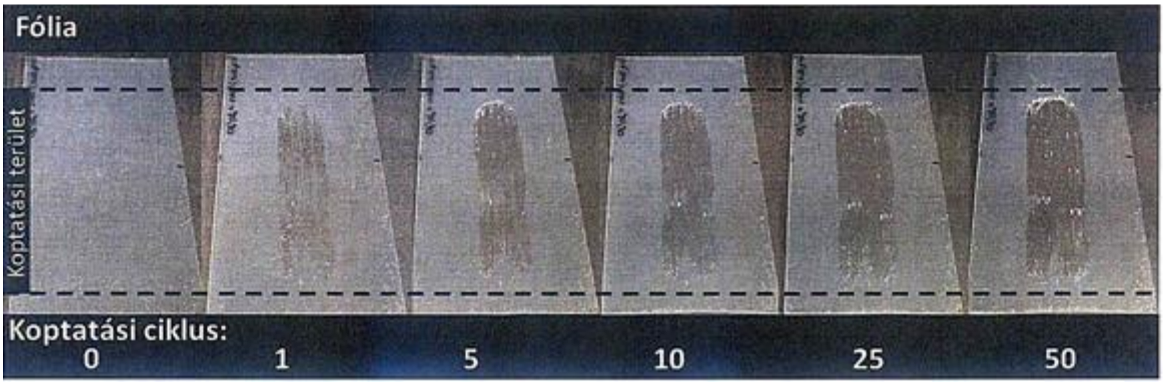

Figure 4. Photograph of composite (photocatalyst / polymer) films formed on a film support after 0, 5, 10, 25, and 50 abrasion cycles.

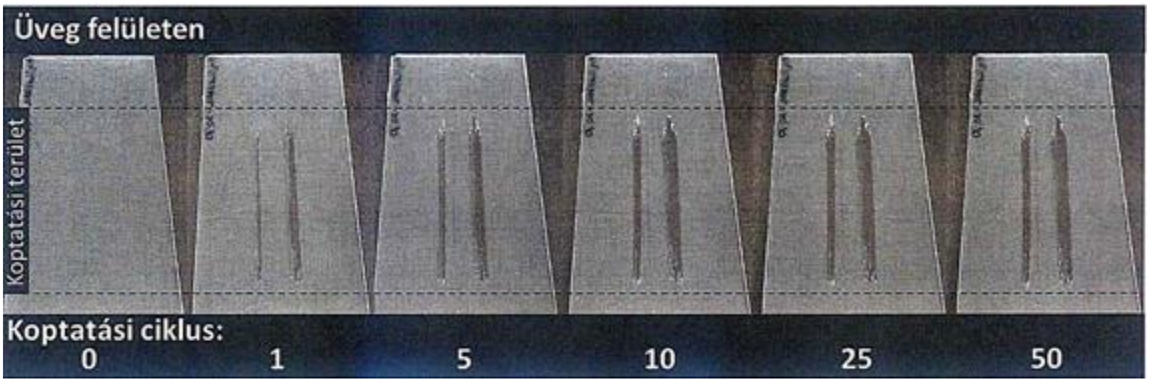

Figure 5. Photograph of composite (photocatalyst / polymer) films on glass substrate after 0, 5, 10, 25 and 50 abrasion cycles

Examining the stability of the composite films, it can be seen on the surface of the film (Fig. 4) and the glass carrier (Fig. 5) that in both cases by increasing the number of abrasion cycles the surface of the formed layer will be damaged. The photos also show that the films formed on the surface of the glass substrate were less damaged (abraded) than the layer formed on the foil, so they showed greater stability on the glass surface.

Further studies were performed on the surface of the abraded layers. In addition to visual images, electron micrographs were taken to examine the extent to which the films were damaged. With this measurement technique it can also be established that the developed resp. the extent to which the abraded layers are present on the surface and how homogeneous their distribution is.

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Electron microscopic examinations of abraded films

The distribution of the composite thin layer is determined by glass and examined on the substrate of the film by energy-dispersive X-ray spectroscopic measurements after the different abrasion cycles. Measurements were performed in the Laboratory of the SZTE TTIK Electron Microscope with a Röntec QX2 detector connected to a Hitachi S-4700 Type II scanning electron microscope using an accelerating voltage of 20 kV. During the measurement, an electron-substance interaction occurs, during which X-rays characteristic of the test substance are created and by detecting it we can obtain information about the elemental composition of the sample.

Figure 6 shows the element distribution of the composite layer after the initial and abrasion cycle numbers - highlighting in red the presence of carbon (C) and the presence of titanium (Ti) in green on the glass substrate. Electron micrographs also show that after 50 abrasion cycles, the composite layer is still present on the surface of the substrate with damage and can exert its antibacterial effect due to the photocatalyst particles still present on the surface.

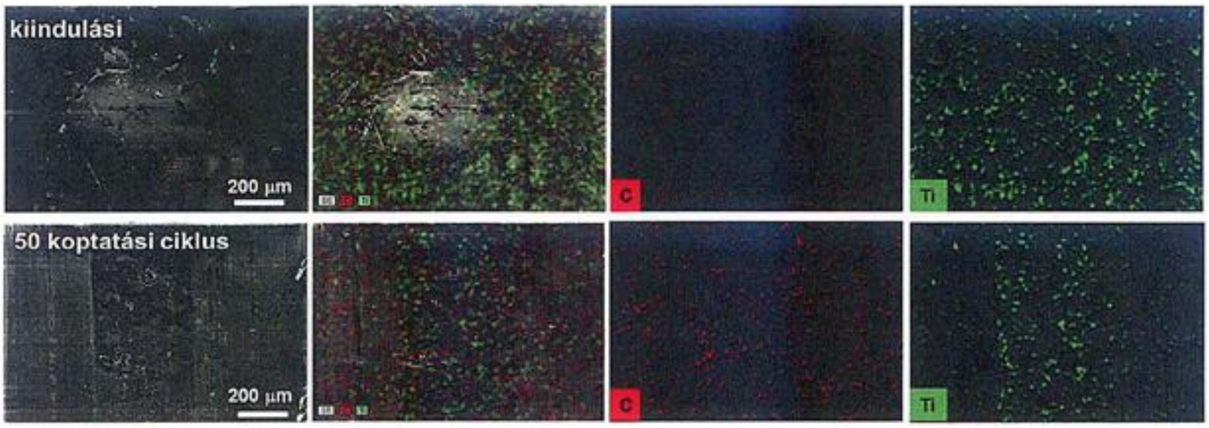

Figure 6. After the initial and 50 abrasion cycles, the element distribution of the composite films (indicating the presence of carbon (red C) and titanium (green Ti)) on the glass substrate surface

Figure 7 shows energy dispersive X-ray spectroscopic images of the initial and abraded composite layers formed on the substrate surface of the film. In this case, too, we can see the presence of carbon (C) highlighted in red and titanium (Ti) in green. The measurement results sufficiently illustrate that after the abrasion cycles the composite layer is present on the substrate surface, as shown by the element distribution of the EDX images for Ti (Ti - green).

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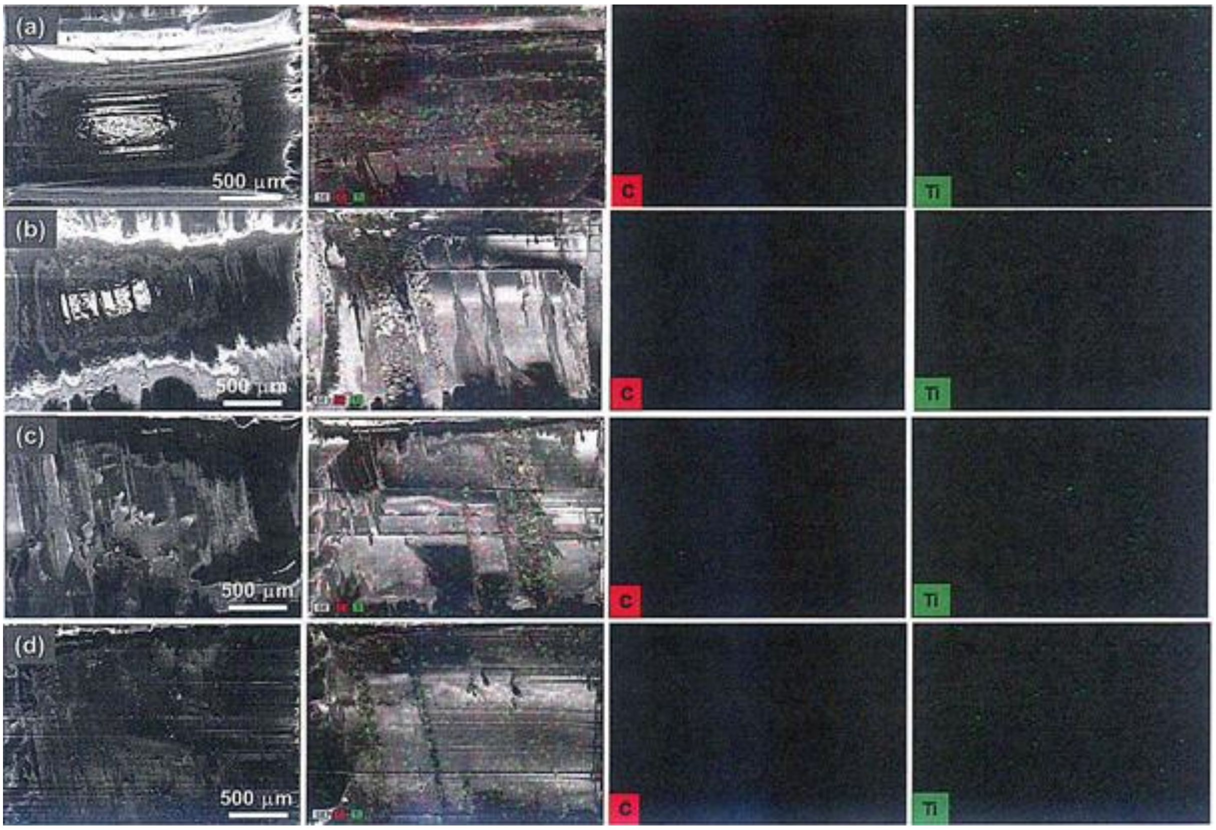

Figure 7. After the initial abrasion cycles (a) and 5 (b), 25 (c), and 50 (d), the element distribution of the composite films (indicating the presence of carbon (red C) and titanium (green Ti)) on the film carrier surface. Based on the above tests, the coating can be used for more than 1 year under typical conditions.

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Dr. Janovák László
Egyetemi adjunktus
SZTE TTIK, Fizikai Kémiai és Anyagtudományi Tanszék

SZEGEDI TUDOMÁNYEGYETEM
Természettudományi és Informatikai Kar
Fizikai Kémiai és Anyagtudományi Tanszék
6720 Szeged, Rerrich Béla tér 1.
Telefon: +36 (62) 546-482

Head of department: Dr. Ágota Tóth, professor
E-mail: atoth@chem.u-szeged.hu