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1 Ethylene tetra-fluoroethylene (ETFE) is a popular building material in modern architecture due to its many advantages. But condensation of water encourages the growth of ugly black mould. Antimicrobial coatings developed at the Fraunhofer ISC could help to stop this in future.

ANTIMICROBIAL POLYMER SURFACES

Microorganisms are classed as bacteria, viruses, mould and fungi and are present around us all the time. They normally do not cause much harm but their growth on surfaces is undesirable for a number of reasons. They cause spoiling, affect the utility value of goods and can at times cause serious illness. The risks posed by microorganisms are universal from health care to the home and in industry.

There is a serious need for a highly effective antimicrobial technology. Work on designing polymer surfaces in a way, which largely prevents microorganisms from growing upon them is been carried out at the Fraunhofer ISC.

The focus is laid on equipping different surfaces, films, fibres or three-dimensional substrates with lacquers exhibiting antimicrobial properties in order to protect consumer goods and sensitive components. Used in food packaging these materials retard germ growth on the surface of food.

Our approach

A unique feature of the Fraunhofer ISC is the use of materials based on hybrid polymers (ORMOCER®, trademark of the Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V., Germany). The chemistry of these materials can be tailored to meet the specific requirements of each product (see Fig. 2).

The materials are synthesized via the wet-chemical sol-gel route combining properties of organic polymers with those of ceramics and glass-like materials on a molecular scale. These nanocomposites have strong covalent or ionic-covalent bonds and can be equipped with antimicrobial functions by incorporating active compounds or by bonding functional silanes which carry antimicrobial active organic groups to the hybrid matrix.

Appropriate coatings can be made which function via release mechanism or contact mechanism. When antimicrobial agents like

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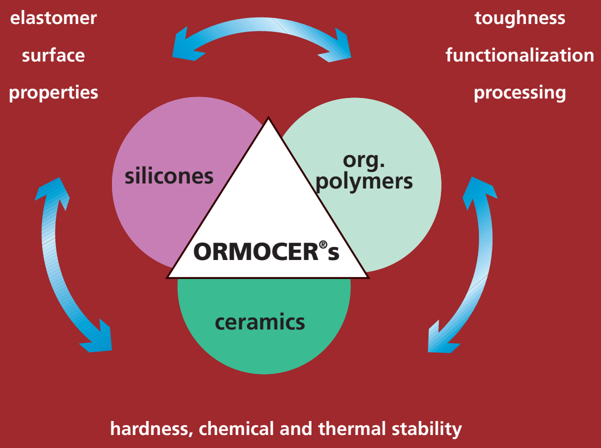

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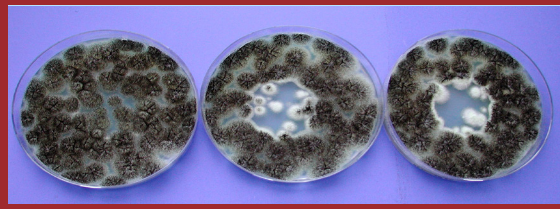

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ammonium silanes are fixed to the hybrid network by covalent bonding, microbes which have direct contact with the surface cannot grow and are subsequently effectively inhibited. The release mechanism works by incorporating active agents like benzoic acid in such a way as to allow its diffusion into the surroundings and thus retards microbial attack.

The large number of combinations and variations of inorganic and organic components allows adaptation to various surfaces and active agent systems. The establishment and growth of microbes on plastics and even on other material surfaces such as metals, paper or wood can be minimized or even completely prevented.

Antimicrobial ETFE

Lately, prestigious buildings such as futuristic sports stadiums have been designed and built using the plastic ethylene tetraflourethylene (ETFE). This transparent membrane is popular because it is light, resilient and self-cleaning and especially because it enables buildings to shine in all colors, though sometimes it is also used just for insulation and heat control.

Condensation of water can cause the growth of mould and yeasts that form ugly black coverings on ETFE. The Fraunhofer ISC has developed antibacterial coatings that inhibit this effect.

By bonding ammonium silanes such as trimethoxysilylpropyldimethyloctadecyl ammonium chlorid (OTA) to the ORMOCER® matrix an antimicrobial effect is achieved via the contact mechanism. As the silanes are bonded covalently, there is no toxicological or ecological risk of migration.

The effectiveness of the coatings were tested using Aspergillus niger, a fungus which causes black mould on certain fruits and vegetables and is reported ubiquitous in soil and also indoor environments.

For this purpose a coating of about 3 µm thickness was applied to ETFE films and put in nutrient growth agar containing the fungus. The diameter of the circle testing bacteria growth (see Fig. 3) clearly confirms the effectiveness of the antimicrobial coating. These coatings have already been applied successfully via roll-to-roll process.

Antimicrobial food packaging

Packaging plays a significant role in supplying consumers with food and must fulfil many demands. Apart from protecting food from light, oxygen, moisture, mechanical stress and soiling, packaging must nowadays ensure the quality during an extended shelf-life. And the trend is to do this with fewer additives and preservatives in the food itself.

Although modern processing of foods achieves good results, active packages are required as protection against microbial contamination arising between the food and the package.

The Fraunhofer ISC developed a coating for packaging materials like PE and PET which releases minimal amounts of the preservatives benzoic and sorbic acid. These preservatives are usually added to food in amounts of 1.5 g/kg. By incorporating them into the coating only a few milligram per kilogram are needed.

This kind of antimicrobial coating can also be applied to paper based package materials and is suitable for solid and soft food products.

2 *ORMOCER®s and their relation to other materials*

3 *Circles resisting bacteria and reference sample show the effectiveness of the antimicrobial coating (© Fraunhofer IVV)*