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FILM STAR: HIGH PURITY PACKAGING IN THE SPOTLIGHT

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Liquid glass coatings could provide easy-to-clean surfaces in healthcare environments, preventing the formation of biofilms and helping to reduce the incidence of HCAIs

Biofilm resistant nano surfaces

Having already won an NHS Smart Solution award for their potential to reduce HCAIs, liquid glass coatings could revolutionise many aspects of hygienic design. **Neil McClelland**, UK project manager at Nanopool, argues such coatings have wide application

Silicon Dioxide Nano Layering Technology (SiO_2 NLT) may be new to the UK but soon this technology will be ubiquitous. This may appear to be glib marketing spin but the technology offers stunning performance in a wide range of environments, not least in healthcare, food production and cleanroom facilities.

SiO_2 NLT has evolved from the manipulation of the sol-gel process – a wet-chemical technique (chemical solution deposition) used widely in the fields of materials science and ceramic engineering. The process has been known for more than 60 years, but recent refinements of it by Nanopool have led to startling innovations.

In essence, Nanopool uses the process to create "liquid glass" or "glass in a bottle". The notion of liquid glass is in itself quite exceptional, but this is only the start of the story.

Via this adapted sol-gel process, molecules of SiO_2 (pure quartz glass) are isolated and held within a solvent of either water or ethanol. This "solution" can then be wiped or sprayed onto almost any surface. The water-based solution is designed for use on absorbent surfaces such as stone, wood and fabrics. The ethanol-based solutions are suitable for metal, glass, plastic and painted surfaces.

When applied to a surface the coating forms a layer of pure glass, which is approximately 100 nanometers thick – 500 times thinner than a human hair. Significantly, there are no resins or bonding agents within the solution; the bottle or wipe contains only water or ethanol and molecules of SiO_2.

Quantum forces (Van der Waals force) enable the SiO_2 layer to polymerise very rapidly. The dominant force is polymerisation, closely followed by adhesion to the ▶

The product is available in a sachet or spray format

The liquid coating is around 100nm thick

◀ substrate. Hard surfaces, such as wash basins, tabletops or telephones, can be subjected to loading within 60 seconds of being coated.

The SiO_2 layer has numerous attributes. With specific reference to clean or hygienic environments, it is felt that the coatings offer significant benefits. Most significantly, the whole of a cleanroom can be coated with a film of invisible, super durable and completely hygienic glass.

In some instances, such as when walls, floors and ceilings are coated, the coatings offer prophylactic and easy cleaning benefits. In other instances the coatings offer enhancements to certain systems, a perfect example being filtration and water purification systems. Ultra fine filters can now be coated with SiO_2; this results in greater efficiency as well as the possibility to clean and reuse the filters.

Nozzles and taps can be coated to prevent the formation of bio-films – a significant issue for organisations that supply drink dispensing units and water coolers.

The key attributes of the coatings are:

- Super phobic – both oleophobic and hydrophobic and so they reject soiling agents
- Flexible – the high level of flexibility allows for the treatment of items such as endoscopes, fabrics, and conveyor belts
- Highly durable – the coatings will withstand tens of thousands of cleaning cycles
- Heat tolerant – the coatings can be subjected to temperatures from -150°C to +450°C
- Antimicrobial – all of the coatings are highly cationic and therefore biostatic
- Antibacterial – adding triclosan to the matrix can create coatings that kill bacteria in accordance with ASTMe 2180 parameters
- Easy clean – all coated surfaces are exceptionally easy to clean as soiling agents cannot bind to the surface; in most instances surfaces can be cleaned with water alone
- Inert – the coatings are inert and physiologically harmless
- Food safe – the coatings are certified as food safe and can be used in food preparation areas
- Acid and alkali resistant – Ph0.5 to Ph12.5
- Breathable at the molecular level – highly significant when coating stone, wood or fabrics
- Undetectable by human senses – the coatings are invisible and too thin to discern through touch
- Free of nanoparticles – the coatings are nanoscale but do not contain any discrete or potentially harmful engineered nanoparticles
- Easy to apply – large areas such as floors, walls and windows can be coated in minutes; no special equipment is needed
- Environmentally friendly – winner of the Green Apple environmental award and the Baden-Wurttemberg environmental protection prize
- Low cost – this is a low cost technology; costs to cover $1m^2$ range from £0.25 to £1.10 (€0.29–1.26)

Many food prep areas have already been treated with the easy clean coating

Having recognised these attributes, it may be valuable to look at how the coatings are currently being used.

Applications within the healthcare and food production environments are well advanced both in Germany and the UK. This technology is one of those chosen for the NHS Smart award in 2008/9 – a project directed at rewarding and promoting new technologies that can reduce the incidence of healthcare associated infections (HCAIs).

All the coatings are tested by leading testing agencies. In addition, clients have conducted independent tests to evaluate the performance of the technology.

For example, a dairy company carried out a trial in Austria in 2008 in one of its food manufacturing/processing facilities. The areas within a cleanroom for cheese packaging were coated with SiO_2. Key areas of the plant were also coated with SiO_2. These surfaces included walls, floors, work surfaces and packaging machines. The trial was conducted over a seven month period. During the test period all coated surfaces were cleaned with water alone at 40°C.

The results showed that the SiO_2 coated surfaces were cleaner than the control surfaces, which were cleaned with a chlorinated agent.

The coating was still in place after seven months. The bacterial counts on the coated surfaces for the month test period were:

Coliform	*0*
Yeast, mould	*<1*

The report characterised these findings as "very satisfactory."

Almost identical results were gained from trials conducted in a meat processing plant and at Spar food processing plants.

The ASTMe 2180 test, conducted by the Fresenius Institute, also confirms that the SiO_2 coatings offer "strong, significant bactericide/fungicide effects against *Escherchia coli, Staphylococcus aureus* and *Salmonella enteritidis*".*

It should be stressed that coated surfaces can be cleaned with cleaning agents, as these agents will not affect the coating.

The SiO_2 coatings will soon become

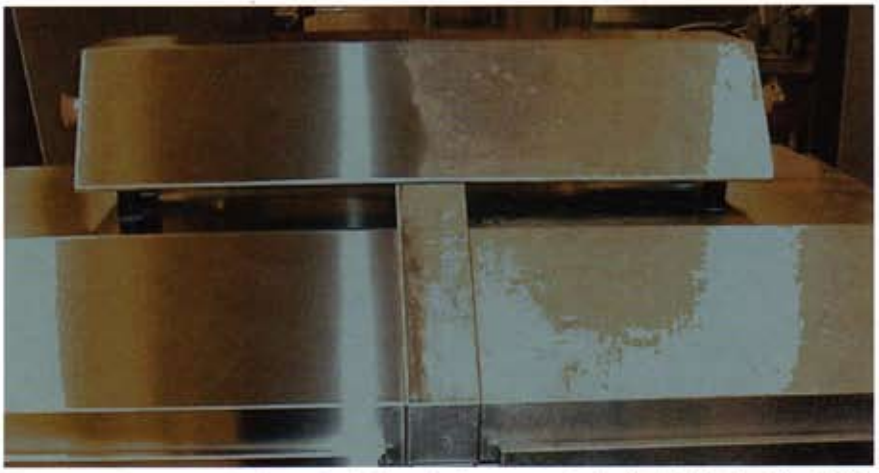
ubiquitous, as domestic variants of this technology are already available in the retail market. The automotive market is embracing the technology for coating fabrics, windscreens, painted surfaces and alloy wheels. Marine coatings, including anti-fouling, will soon become available and certain stores within the UK have already had their washrooms and food prep areas coated with the technology.

Almost all surfaces can be coated but the SiO_2 will not bond efficiently to Teflon or other non-stick coatings; additionally all surfaces must be completely clean prior to application as a fingerprint can be 100 times thicker than the coating.

The only action that will remove the coating is extreme heat/cold, abrasion, strong alkali or etching acid. The coating will not corrupt or decay.

If the coating is subjected to a great deal of abrasion then it will last for a shorter period of time. The domestic grade of coating will last for approximately one year on a wash basin that is subjected to normal use. The professional grade will last for approximately two years. The professional grade coatings are slightly thicker (150nm).

There are specific coatings for wood, fabric, stone, glass and ceramic, metal and plastic. The molecules within the coating are oriented towards the general valence of the substrates on which they will sit.



This image shows a unit where the left hand side was coated with $NPSiO_2$ but the right hand side was not coated prior to use. After use both sides were cleaned with water

Nanopool has created more than 30 variants of the SiO_2 coatings. Some of these are highly specialised but most surfaces can be coated with the standard products. Surfaces can also be recoated in a very straightforward manner; simply clean the surface and apply.

At the micro level the coating is slippery but at the macro level it is not. In certain instances, for example shower rooms, the treated surface is less slippery due to the prevention of a bio film.

SiO_2 technology is exceptional and will be of enormous significance to the cleanroom industry but, as is often the case, it needs to be seen to be believed. **CT**

CONTACT

Neil McClelland, UK Project Manager
Nanopool GmbH
- neil.mcclelland@nanopool.co.uk
- www.nanopool.eu

Footnote

*Copies of test data are available from Nanopool on request