Antibacterial and antiadhesive surface coatings for implant materials

Philipps-Universität Marburg
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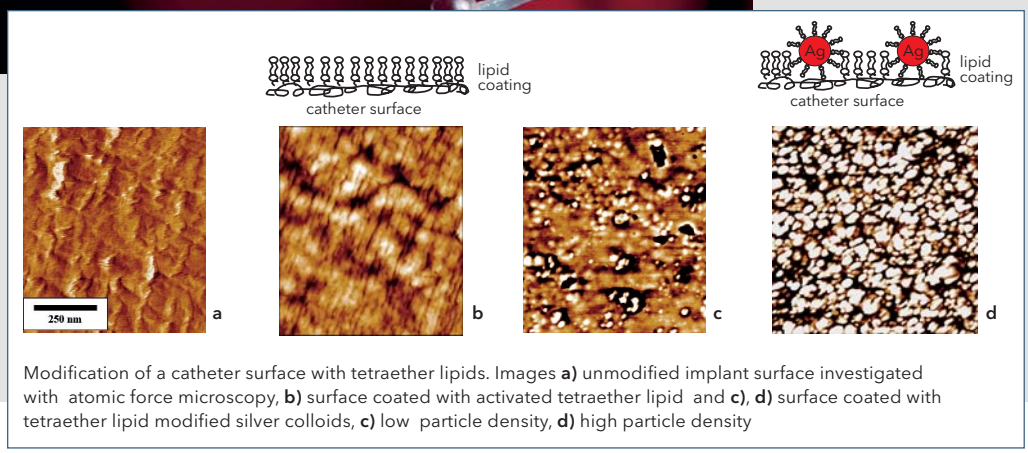

Modification of a catheter surface with tetraether lipids. Images **a)** unmodified implant surface investigated with atomic force microscopy, **b)** surface coated with activated tetraether lipid and **c)**, **d)** surface coated with tetraether lipid modified silver colloids, **c)** low particle density, **d)** high particle density

Each year, urinary catheters are applied to about 1 million patients in hospitals and extended-care facilities. Catheter-associated urinary tract infections (CI) are the most common nosocomial infections in hospitals and nursing homes, comprising more than 40 % of all institutionally acquired infections. Nosocomial bacteriuria or candiduria develops in up to 25 % of patients requiring a urinary catheter for >7 days. Most CI's are asymptomatic and thereby rarely extend hospitalisation and increase costs only slightly. Despite this, they are still the second most frequent cause of nosocomial bloodstream infections and led to 6500 deaths in the USA in 2001. Like other asymptomatic infections, CI's are often preventively treated with antibiotics, leading to unnecessary high usage of these antibiotics.

Latest hygienic standards can minimise the contamination of intracorporal parts of the catheter, but one major problem is still unsolved: the ability of some bacteria to grow on several materials, finally building up spreading biofilms that are difficult to treat. Furthermore, many of the bacterial strains found on catheter surfaces acquired resistance to antibiotics and represent a hazardous germ reservoir. The most important of these are multidrug-resistant Enterobacteriacae other than Escherichia coli, such as *Klebsiella, Enterobacter, Proteus,* and *Citrobacter, Pseudomonas aeruginosa, enterococci* and *staphylococci*, and *Candida spp.*. One potential method to protect biomaterials from bacterial adhesion and cultivation of biofilms is the surface modification with thin films of anti-adhesive and anti-microbial substances such as silver ions, chlorhexidine and phosphaditylcholines etc.

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The major innovation of the new surface coating is the development of a ultrathin but stable anti-adhesive and anti-bacterial barrier on different catheters made of polyurethane or silicone based on a covalently attached tetraether lipid film. The tetraether lipids are the major part of the cell membrane of the archaeon *Thermoplasma acidiphilum* which is grown in environmental milieu of sulphuric acid at pH 2 and 56° C. The absence of double bonds in the hydrocarbon chain and the ether bonds to the glycerol's guarantee the resistance towards hydrolytic, oxidative and other (bio)chemical attacks. Therefore, they will presumably be chemically stable in the urethral environment. In addition, colloidal silver particles and a antibiotics controlled release systems are integrated in this coating to inhibit the expansion of residual bacteria into biofilms.

The surface of the catheters could be protected from the adhesion of serum components and bacteria for 36 hours, while the unmodified material was completely covered. The additional antibacterial modification leads to a reduced bacterial growth over a time period of four weeks. It was found possible to control the surface morphology in the nanometer scale by choice of the process parameters.

References:
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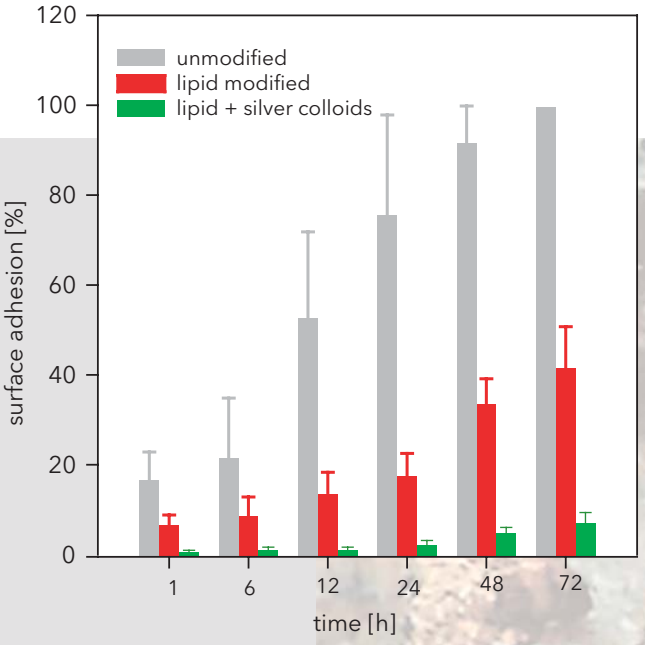
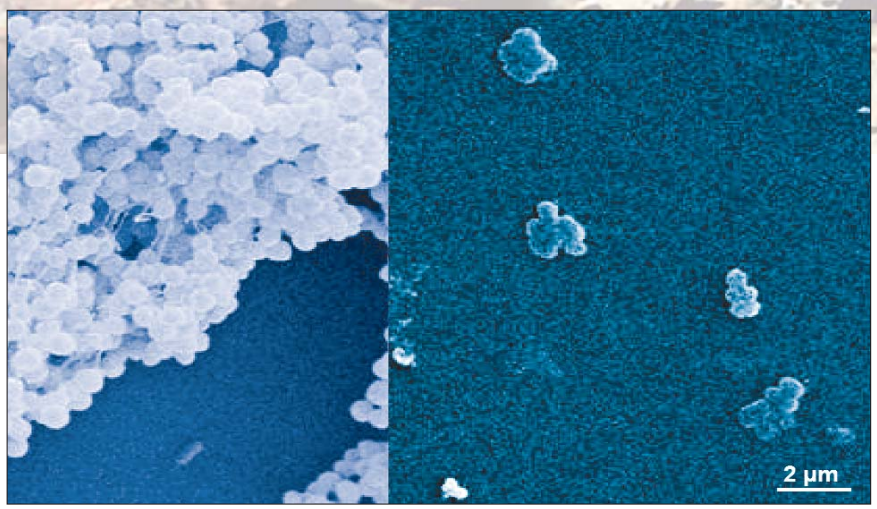


Quantification of the Bacterial (*E. coli*) adhesion in dependence on the surface modification of the catheter

The ideal living conditions of *Thermoplasma acidophilum* self-heating cole pile pH 1-2, 45-90°C



Bacterial (*E. coli*) adhesion investigated with scanning electron microscopy.

Left: unmodified surface

Right: antiadhesive coating (with tetraether lipids)