Towards surface engineering in hygienic applications

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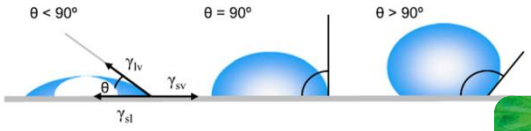
Introduction

Efficient pre cleaning, disinfection and sterilization of medical equipment used in diagnosing and treatment of patients are crucial for safe care of patients . Common for medical devices are high requirements of hygienic and cleanliness properties. Development of medical equipment is of increasing complexity level which means higher demands on cleaning, disinfection and sterilization processes.

Clean ability properties are controlled by a combination of material selection, surface chemistry and surface roughness. Properties like wettability, hydrophobicity and oleophobicity has impact on a surface cleanliness, its ability to repel biofilm, proteins and other debris formation, and clean ability. It is possible to improve clean ability by optimization of surface specification..

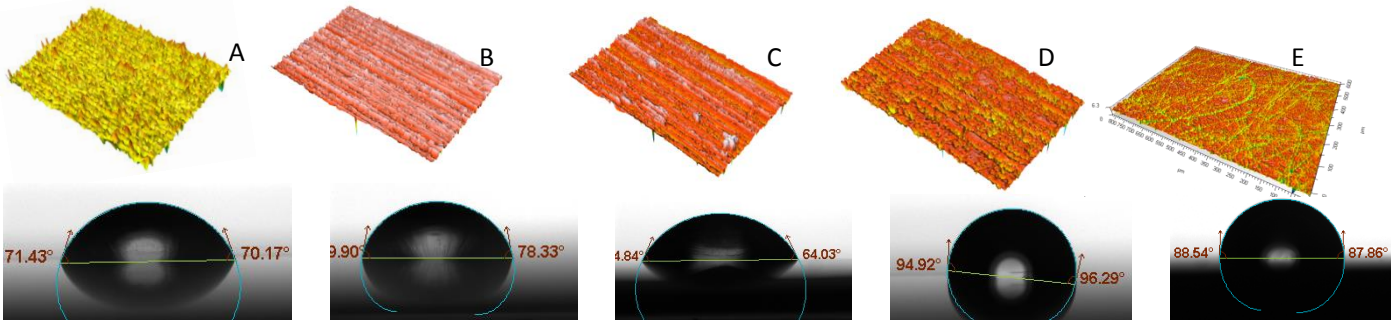
A large amount of manual workload, media consumption and detergents usage is put in to achieving a safe and quality controlled sterile goods handling and hygienic work environment. Functional surface engineering offers a method to develop surface textures that enables a improved clean ability. By optimizing surface roughness there is an opportunity to reduce process times, media and detergent consumption.

Contact angle measurements have become very important in many different industrial processes as it studies the wettability when a liquid and a solid surface
interact. Contact angle measurement involves dripping a liquid onto a surface to measure the angle between the surface and the drop. The angle is defined by the intersection of the liquid-solid and liquid-gas interface by applying a tangent at
which the liquid droplet makes contact with the surface as visualized in figure below
Small contact angles <<90° correspond to high wettability and angles>>90° corresponds to low wettability. A contact angle that is higher than 90° means that the surface is repelling the liquid. The contact area between the droplet and the solid is then minimized and form a compact liquid droplet. When using water as a liquid the higher the contact angle, the more hydrophobic a surface is and if the angle is less than 90°, then the surface is hydrophilic. Super amphiphobicity is an effect where surface roughness and surface chemistry combine to generate surfaces which are both super hydrophobic and super oleophobic, i.e., contact angles (θCA) greater than 150° along with low contact angle hysteresis
(CAH) not only towards probing water but also for low-surface-tension 'oils'.



Materials and methods

This paper investigates the cleanliness aspect of surfaces which is a measure on how hygienic and easy to clean the surface is. Surface A, B C and D represents stain less steel (316 L) with different surface finishies. Surface E is a Corian® material.A selection of surface roughness parameters are chosen to describe the different surfaces. The contact angles measurements were carried out 5 times per surface, with clean water, and a drop volume of 5 ul. The pictures below shows a representative average value of contact angle. The deviation from meanof the contact angle measurements were max +- 5 º.



Parameter (um)	Surf A	Surf B	Surf C	Surf D	Surf E
Sa	0,12	0,23	0,36	0,16	0,34
Sq	0,16	0,29	0,53	0,219	0,57
Sal	2,66	4,4	13,9	7,51	5,62
Sdc	0,32	0,62	0,80	0,356	0,79

Summary

This study has no ambition to be complete but shows that different surface finish has impact on wettability. To be able to introduce novel materials in medical devices and equipment it is required to establish methods to evaluate hygienic properties. It can be seen that surface D and E shows higher degree of hydrophobicity than surface A, B and C but the selected surface roughness parameters can not explain the result. Sa alone is not enough to describe a hygienic surface. It implies that there are other surface features affecting the contact angle. The surface C that shows the lowest value of hydrophobicity is very common both in medical device and food industry.

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Future work

To improve understanding how to design medical equipment with high cleanability properties extended measurements of contact angle with other liquids than water, and surface free energy, together with surface roughness evalutaion must be performed on a wider variety of materials and surface specifications.

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