Injection Molded Nanostructures Together with Hearing Instrument Materials

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***Abstract*—A human right and strong need is to be able to move freely and therefore robustness of the hearing instrument is very important for the users since they depend on their instruments. While many hearing aids of today are able to fulfill many functions that enables hearing a lot of the hearing aids provided still do not give the users an experience of total freedom. This is because many of the instruments have problems with water ingress. Being stopped because of being hearing impairment in everyday situations are beyond frustrating e.g. removing the instrument due to heavy rain. Still if no other options are present, we adapt. We feel fine with not being able to hear when it is raining outside, but should we?**

Imagine a water droplet placed on water hating surface. Since the water really do not want to be in contact with the surface, the droplet will try to escape. The result is an almost perfect spherical droplet. Now visualize that the surface is slightly tilted. Since the water droplet dislikes the surface, it will start to roll off. This effect can be seen on the leaves of many plants in nature, especially the Lotus flower. In nature, this effect is utilized to clean the leaves from dirt, so it can absorb light from the sun needed for the photosynthesis. The cause to this water hating effect is tiny structures on the leaves, in the nanometer range. Now think about if this effect could be applied to the surfaces of hearing aid materials? Would it improve the water ingress of the hearing aid, providing a better experience for the user? That is what this project was investigating, using a new technology to create nanostructures on the surfaces of hearing aids.

To understand how a nanostructured surface can affect water ingress, material wetting properties needs to be understood. A material can either be hydrophobic, meaning water hating, or hydrophilic, meaning water loving. These are qualities the material will have in its natural state. What can been seen in research is that if a material with a flat surface gets a certain roughness applied to it, the water hating or water loving effect will be enhanced. When a liquid is in contact with a surface it is only the outermost layer that decides if the surface is hydrophobic or hydrophilic. This means that the most important thing is to find a material where the nanostructures can be created to give the surface a roughness. Then if a hydrophobic surface is desired a chemical coating that is hydrophobic can be applied to generate a more water hating surface.

Hearing instruments usually consists of different parts that are merged into one unit. No matter how well the parts fit into each other, small gaps will occur between these parts. This gap is called a capillary and contributes to the problem with water ingress. If a hearing instrument is made by a water loving material, risks are high that water will start to creep into the small capillaries. When the water has reached into the instrument, it can get in contact with the electronics inside. In a worse case scenario, the hearing aid will be damaged. However, if the material of the instrument were to be water hating instead, a theory were that the water could be stopped, because the water really do not want to be in contact with the surface. This will hinder the water from creeping into the capillary.

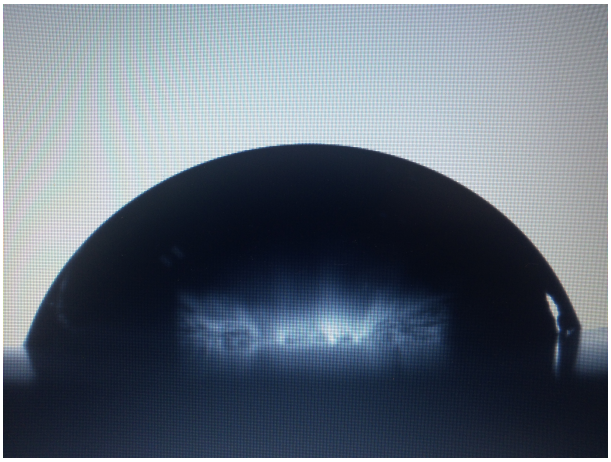

Fig. 1: Image showing a droplet on a surface without nanostructures.

From the different tests it could be learned that it is possible to create nanostructures on the surfaces of all the tested hearing instrument materials. When using a nanostructured surface with a hydrophobic chemical coating to stop water from entering a capillary, it could be seen that it did have a stopping effect.

Conclusion

This project shows that the nanotechnology does change the material wetting properties and can be used to control the capillary effect. Maybe these finding can contribute to the development of even more robust and water resisting hearing instruments, giving the user a better experience.