1.5.3. CORROSION PREVENTION BY DETECTION OF CORROSIVE LIQUIDS BY OPTICAL FIBRE SENSORS

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Introduction. Corrosion caused by liquids present in engineering structures can rapidly change the surface properties of components, and that will finally endanger the functionality of the particular system. However, if there is information on the presence of corrosive liquid available, corrosion treatment and even corrosion prevention can start at a very early stage. The basic idea is to detect corrosive liquids by extended optical fibres sensors. Surface plasmon resonance (SPR) offers the possibility to detect liquid contaminants at the surface of the optical fibre in a quantitative and even analytical way.

Optical fibre sensors in general have a number of advantageous properties over other sensor types, one is the small diameter which is typically in the range of 0.2 – 0.6 mm. This frequently solves the problem if limited space is available. Moreover, optical fibres can work in a range up to kilometres, enabling an extended sensing area. The detection of corrosive liquids (or at least of just liquids) is possible by surface plasmon resonance which occurs on the surface of decladded optical fibres if an appropriate metal coating is present. The set-up is relatively easy to implement, and the system is inert to most electromagnetic interferences.

The sensitivity can dramatically be enhanced by functional coatings, and miniaturisation is required for the light source and for the read-out unit, and the stability of the baseline still has to be determined.

The principle of surface plasmon resonance is relatively easy to understand. When a glass surface is covered with a metal layer, such as gold, the light propagating in the optical fibre will come in resonance with the electrons in the metal layer when a number of requirements are met. One of them is the appropriate thickness of the gold layer and the other one is the optical properties of the dielectric material covering the gold layer. The usual parameter is the refractive index and the surface plasmon resonance is thus a measure of this fundamental optical quantity.

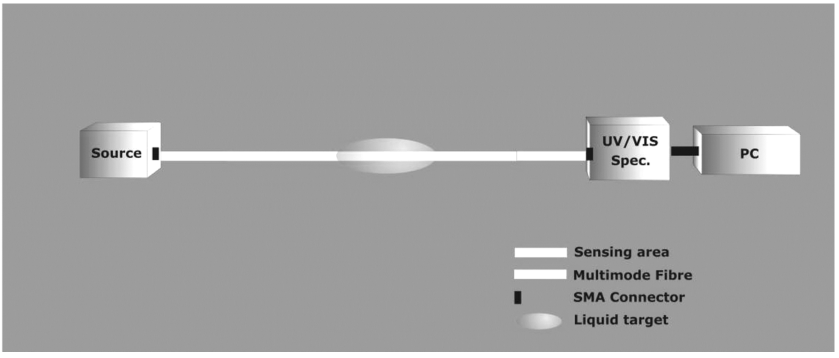

Fig. 1. Set-up for surface plasmon resonance measurements with optical fibre sensors for liquid detection

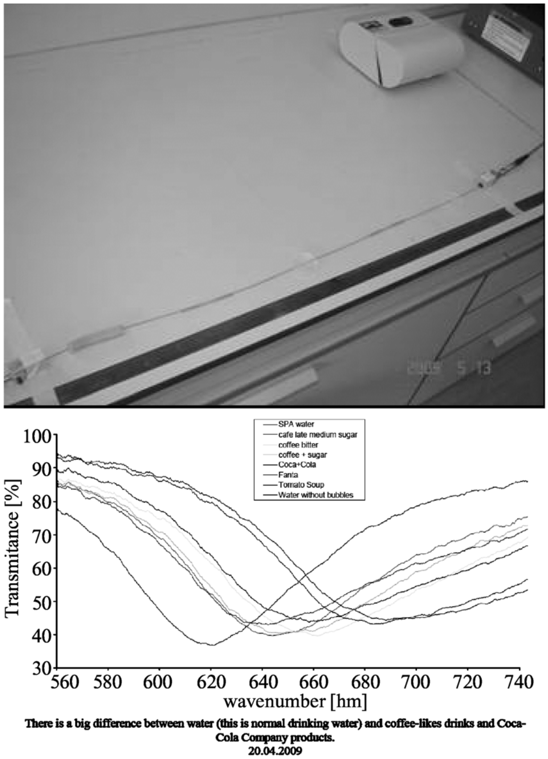

Fig. 2. Set-up for surface plasmon resonance measurements for liquid detection. Spectra recorded for different relevant liquids (left) and extended fibre with selected sensing positions (right)

Basic results and discussion. An experimental set-up is shown in fig. 2, left picture. With it, key results were obtained engaging the further implementation of SPR optical fibres sensors. One of the biggest problems with spilled liquids occurs in e.g. the galley area of airplanes. Therefore, the optical fibre in our case was exposed to various liquids that appear to be responsible for corrosion of the floor beams, like cola, coffee and soup. Clear absorption signals were recorded indicating the ability of the sensor to detect those liquids.

Furthermore, in the paper the implementation strategy is further explored, as well as the advantages and disadvantages of the technology proposed.

Summary. Optical fibres can be a robust and reliable tool for liquid detection that might be a cause for corrosion problems in endangered engineering structures. This is presented for application in airplanes, but this can in principle be extended to many other fields of application.

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