Carbonate based Nonionic Surfactants for Smart Cleaning of Works of Art

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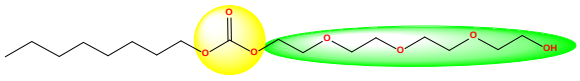
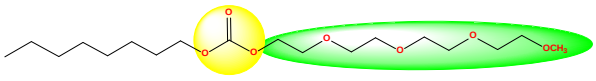
Smart and gentle cleaning of painted surfaces is a challenge for modern conservators. In the past, various traditional cleaning liquids, such as neat organic solvents, potash solution, wine, vinegar, bile, etc. were used but in view of their action, recycling and toxicity they are no longer considered. Most of the modern cleaning formulations are based on nanostructured fluids involving water, organic solvent and surfactants. Self-degradable surfactants are particularly suitable for such systems. It is considered important not to have residual surface active components on the painted surface when the water and the organic solvent has evaporated. It is an added advantage if the self-degradation of the surfactant results in fragments volatile enough to also leave the surface spontaneously. Another important condition is that the self-degradation should not lead to acidic products. The binder in both oil-based and alkyd-based paintings is susceptible to acid hydrolysis. For this reason, ester- and amide-containing surfactants, which are otherwise a natural choice as cleavable amphiphiles,[1] are not suitable for the purpose.

We have explored the route of carbonate-based nonionic surfactants. Two classes of such amphiphiles have been synthesized, non-capped and capped, and the structures are shown below. They have been made by reacting an *n*-alkylchloroformate with a short polyethyleneglycol/ polyethyleneglycol monomethyl ether at low temperature. The surfactants have been characterized by tensiometry and other physicochemical methods.

The degradation of these new surfactants was examined under different conditions by performing NMR and surface tension experiments. The pH dependency was studied in some detail. The fate of the hydrolysis products, i.e. octanol and an oligo(ethylene glycol) or the methyl ether of an oligo(ethylene glycol), on a surface was monitored by QCM-D and other surface analysis techniques.



Non-capped



Capped

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[1] D. Lundberg, M. Stjerndahl and K. Holmberg. Cleavable Surfactants. In: *Encyclopedia of Surface and Colloid Science,* 2nd ed. (P. Somasundaran, Ed.), Taylor and Francis, New York, 2010.