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Spectromicroscopy Studies of Biofilms on Membrane Filters

J.Thieme (U. Goettingen, Germany), S. Hegendorf, U. Panne, R. Niessner (TU Munich, Germany)

Beamline(s): X1A

Introduction: Membrane filters are used more and more to clean contaminated natural water via cross-flow filtration. Depending on the type of contamination clogging of filter pores might occur, resulting from biopolymers/biofilms (extracellular polymer substances EPS) and hydrocolloids in and around the pores of membrane filters. This clogging leads to a reduced throughput capacity. Momentarily, the extent and mechanism can hardly be predicted from water quality parameters as size distribution of hydrocolloids, concentration of EPS or growth of biofilms [1,2]. Therefore, the aim of these studies is to follow clogging of defined filters with spectromicroscopy and to develop models on the basis of these results.

Methods and Materials: Filters with pore sizes of 10 µm have been treated in a percolation equipment, leading to biofilms of different extent. The biofilm growth has been stopped chemically and the obtained samples have been studied in the Stony Brook STXM at beamline X1A in comparison to membrane filters without biofilm. To obtain spectral information as well as spatial information, the stack recording capability of the STXM has been found extremely useful. To evaluate the data, the appropriate stack software has been used [3].

Results: The images in figure 1 show the typical appearance of a clogged pore of 10 µm diameter. The energies used for it are E=282.5 eV and E= 295 eV, i.e. below and above the K-absorption edge of carbon. A comparison shows in addition to an inorganic structure, seen in the lower half of the left image, most of the clogging material as organic. To identify more clearly the source of this organic material, spectra can be taken from the stack data. The plot in figure 1 shows the spectrum taken from the organic substance in the upper half of the pore. The identified peaks might be assigned preliminarily to the transitions π^* of the C=C double bond at E=284.6 eV and 3s of CH_3,CH_2 at E=287.6 eV, however, a thorough evaluation has to confirm it.

Conclusions: The scanning transmission X-ray microscope is due to its capability to record spectral data simultaneously to spatial data an excellent choice for approaching this issue. Especially, taking stacks is extremely helpful. Thus spectromicroscopy can be used to trace pollution of membrane filters. However, prior to reliable statements about this pollution, more of these studies have to be performed.

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References:

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[3] C. Jacobsen et al., J. Microscopy 197, 173 (2000)

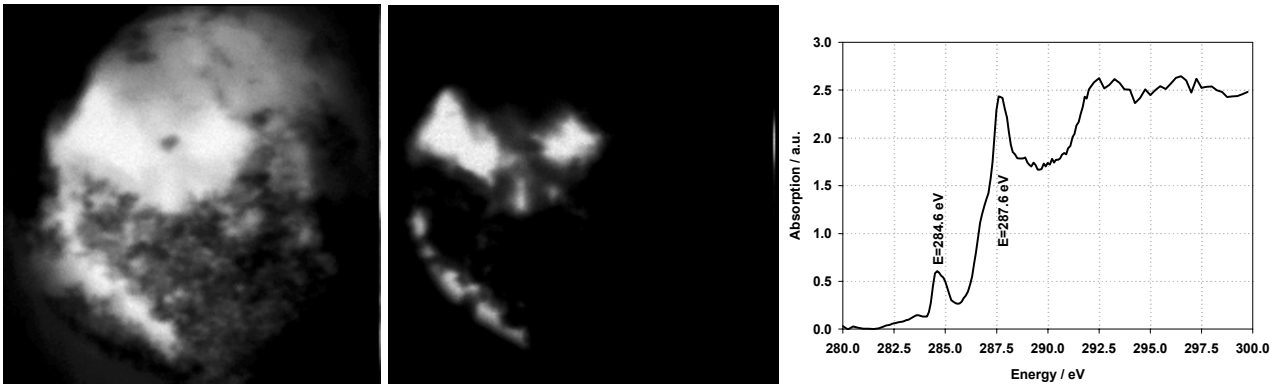

Fig. 1. X-ray images of a clogged micropore, taken at E=282.5 eV (left) and E=295 eV (right), image size 200 x 200 pixel, pixel size 50 nm. The spectrum was taken from the upper half of the clogging material.