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ELSEVIER

Regular micropore filters for X-ray fluorescent analysis of atmospheric aerosols and suspensions in liquids

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Abstract

The first experience of the application of film micropore filters with regularly spaced holes of 0.4 μm in diameter for X-ray fluorescent elemental analysis of atmospheric aerosols and water suspensions is described.

The efficiency of regular filters, when they are employed as a collector for Synchrotron Radiation X-ray Fluorescent Analysis (SRXFA) of the elemental composition of atmospheric aerosols and suspensions in liquids, is tested.

Film micropore filters with regularly spaced holes were manufactured by the technique of deep X-ray lithography using the VEPP-3 electron storage ring at the Budker Institute of Nuclear Physics (Novosibirsk) [1]. The filters are Mylar films of a thickness of 2.5–10 μm with 0.4 μm diameter holes, 1 μm distant from each other along both coordinates. The advantage of regular filters is their larger number of holes per unit area and their uniformity (there are no superimposed holes). Filters of 2.5 μm thick mylar with 30 mm diameter can stand pressures up to ~ 3500 Pa without any additional supports. Filters have a geometrical transparency of about 15%. The value of this parameter can be increased up to more than 50%. Apart from Nuclepore filters, the regular microporous membranes have no dispersion of pore sizes caused by merged holes.

As the regular filters contain a larger number of holes per unit area, it is possible to increase the signal/Compton background ratio for SRXFA of extremely small amounts of elements. Due to this reason it is of special interest for the application of such types of filters, instead of Nuclepore filters, for environmental studies of atmospheric aerosols and water suspensions. In the test experiment an air sample (0.8 m^3) and a water sample (27–79 cm^3), collected in Novosibirsk, were filtered using 0.55 cm^2 regular filters and Nuclepore filters. The electronic micrographs of the exposured filters are presented in Figs. 1 to 3.

Table 1
The concentration of some elements in the air near Novosibirsk city, measured by the SRXFA technique

Element	Concentration at the regular filter (ng/cm^2)	Concentration in the air (ng/m^3)
Ca	677	470
Fe	168	117
Br	2.4	1.7

These filters were analyzed by the SRXFA method at the VEPP-3 storage ring [2] with 23 keV excitation and 5 min measurement time. K-alpha fluorescent lines of elements from Ca to Mo and the L-alpha line of Pb were registered using a Si(Li) solid state detector. As reference samples for a quantitative analysis filters containing 10 μg cm^2 of Ca, Cr, Fe, Cu, Sr and Pb were used [3]. The examples of data obtained for some elements are presented in Tables 1 and 2. Table 3 shows the effectivity of a regular filter as a collector of water suspensions for a number of chemical elements in compariso to a Nuclepore filter. Some differences in the results may be caused by the

Table 2
The concentration of some elements in the water suspensions measured by the SRXFA technique

Element	Concentration at the regular filter ($\mu g/cm^2$)	Concentration in the water suspensions ($\mu g/l$)
Ca	5.1	104
Fe	8.8	180
Zn	1.96	40

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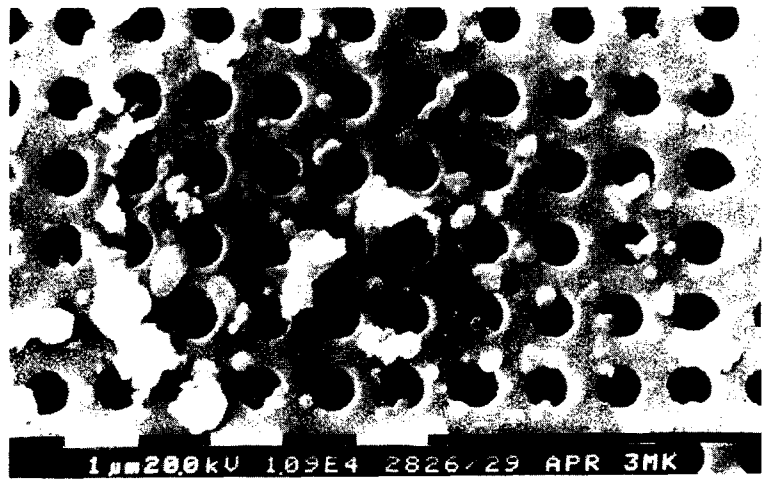

Fig. 1. Atmospheric aerosol particles collected at the regular filter.

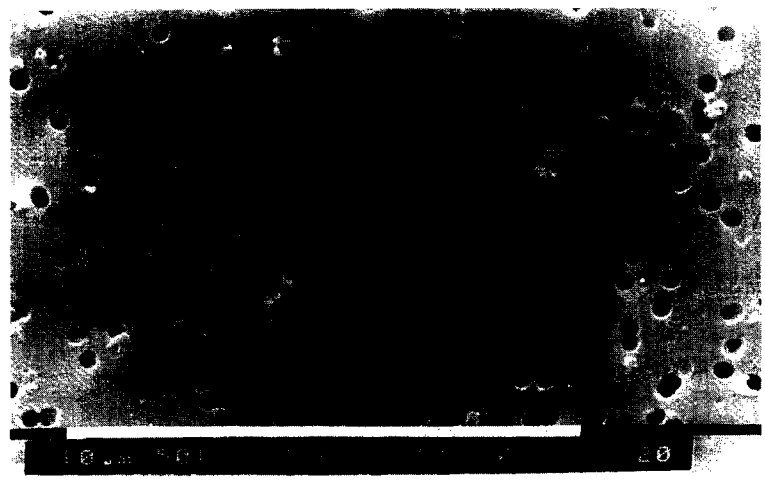

Fig. 2. Atmospheric aerosol particles at the Nuclepore filter.

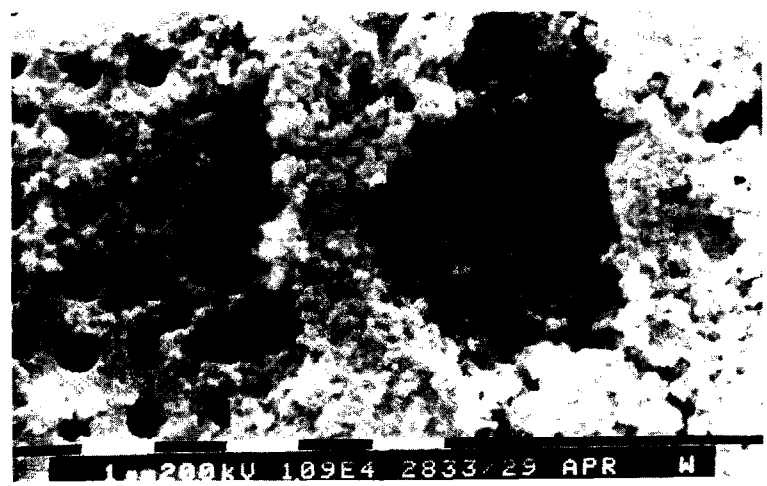

Fig. 3. Water suspensions collected at the regular filter.

Table 3
Element concentrations ($\mu g/cm^2$) for regular and Nuclepore filters after filtration of 145 g/cm^2 of water

Element	Concentration at the regular filter ($\mu g/cm^2$)	Concentration at the Nuclepore filter ($\mu g/cm^2$)
Ca	8.8	7.5
Ti	0.34	0.29
Mn	1.22	4.8
Fe	14.6	8.9
Cu	0.1	0.63
Zn	0.43	0.64
As	0.06	0.03
Sr	0.05	0.04
Pb	0.04	0.06

existence of superimposed holes in the Nuclepore filter and a little difference between the average diameters of the holes for Nuclepore and regular filters.

References

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