ION BEAM USAGE IN ENVIRONMENTAL CHARACTERIZATION

L. POPA_SIMIL
LAAS - Los Alamos Academy of Sciences, Los Alamos, USA

There are many circumstances we were interested in getting more knowledge on environmental atomic and molecular composition, as monitoring pollution, identifying pollution sources, looking for air, water and soil on surface and underground composition. Accelerator based techniques offer a large palette of measurement capabilities, with high sensibility and accuracy, requiring small samples but they are expensive and time consuming, and need to be organized in such a manner to get a holistic characterization of an array of interest in a single sampling, or repetitive for trend identification.

Starting in 1980 in Romania, I have started measuring environment as related to singular events, to industrial pollution and general environment research using nuclear technologies. First sets of measurements were using gamma-spectroscopy associated to geodesic studies or singular events forensics. Samples from environment were taken and measured for elemental and molecular composition using, PIXE, PIGE, CPAA and NAA. Chernobyl accident found us so unprepared to reliably characterize the impact in air and on ground and water, and we used a combination of measurements, trying to identify the contamination not only with radioactive material, but with stable elements also. The interest was to correlate various contaminants in air bound to various size aerosols, and we started developing our multi-stage stacked filter unit, that was applied successfully to water, lubricant and wine filtration, using tangential filtering units for large filtered volumes. Atmospheric pollution, and atmospheric corrosion, became important, and we have used TLA method to characterize the material corrosion in air, and simultaneously measure the acidity in air using special filtration unit in parallel, and taking precipitation samples. The need for measuring bio-samples which are evaporating in vacuum and under beam's energy deposition led us to the development of methods with beam extracted in air, or controlled atmosphere, generically called bio-PIXE.

During 1990s we were interested in tracking pollution, and we used the protocols developed by Nagoya Technical Univ., Prof. Susumu Amemyia, which was based on mobile air samplers with 0.4μ and 5μ pores, tuned for industrial pollution, and the IMPROVE protocol, developed with Prof. Thomas Cahill at UC Davis, CA participation, using 0.8 μ and 8 μ filters, simulating better human buccopharyngeal cavity, augmented with nearby soil, vegetation and water samples. Starting from mid 1980s we have added remote sensing capabilities using thermos and multi-spectral vision for characterizing short range transportation, where the data were correlated with elemental analyses of samples from the area in order to produce signature patterns for image automatic identification. Measurements across US, Europe and Romania were made, mainly measured by PIXE and XRF, while stoichiometry was used to identify substances.

After year 2000, soil and vegetables samples were taken to scale the impact in the area of the so called "nuclear legacy", on local environment and looked to more evolved AMS methods using RGAs in order to better identify the molecular compositions and develop accelerator based forensic installation, using both the analytical and radiolysis capabilities, in an effort to extract maximum information from the measurements, sometimes performed in real-time.

These experiments drive us to the conclusion that for best accurate and complete results one has to use a plurality of methods applied quasi-simultaneously on the same sample.

In most of the cases was difficult to say which was the real contribution of a singular event on the composition of elements and molecules in an area, and most often we used in volume sampling to obtain

the densities of each component, and from those variation to estimate the single event's contribution. In this case accelerators have to cooperate doing simultaneously elemental analysis and atomic mass spectroscopy, to identify all molecular species, and to corroborate these results with CPAA, NAA and RBS for solid samples. Radioactivity is also an important feature and makes a more complex image. In some cases, using radiolysis and sequential measurements allows obtaining more complete information about volatile substances, which may be detected with Residual gases analysers online with the beam, is sample temperature is also considered by using IR imager.

It has been detected an affinity between some substances and elements to associate with certain particulates and aerosols, as in the case of wine clearing by ultrafiltration, where wen removing a class of particulates was changing the wine scent and aromas, and a study in depth was required to better understanding these manifestations.

Using the lessons learned, in order to get competitive, fast and useful data, there is the need to consolidate the accelerators in clusters application ready, with some process automation, able to process many samples a day under quality assurance standards. Another direction is to develop mobile equipment for on-site measurements that will deliver the primary data collected during the sampling time, covering all aspects of the studied area. That will represent virtual centres of excellence, assuring accelerators an important role in environmental and micro-particle knowledge progress.

REFERENCES

[1] Innegraeve, O, Blanchet, X, Muntele, C I, Muntele, I C, Zimmerman, R L, Popa-Simil, L, Voiculescu, D, Racolta, P M, and Ila, D., PIXE pollution studies across Europe. Nuclear Instruments and Methods in Physics Research. Section B, Beam Interactions with Materials and Atoms, United States: N. p., 2002.

[2] Amemiya, Susumu & Masuda, Toshio & Popa-Simil, Liviu & Mateescu, Liviu. (1996). Mapping of aerosols' elemental distribution in two zones in Romania by PIXE analysis. Nuclear Instruments & Methods in Physics Research Section B-beam Interactions With Materials and Atoms - NUCL INSTRUM METH PHYS RES B. 118. 403-407.10.1016/0168-583X(95)01088-2.

[3] Susumu Amemiya, Toshio Masuda, Liviu Popa-Simil, Claudiu Muntele, Dana Voiculescu and Petru Mihai Racolta, Environmental Studies In Some Romanian Regions, International Journal of PIXEVol. 09, No. 01n02, pp. 29-33 (1999)