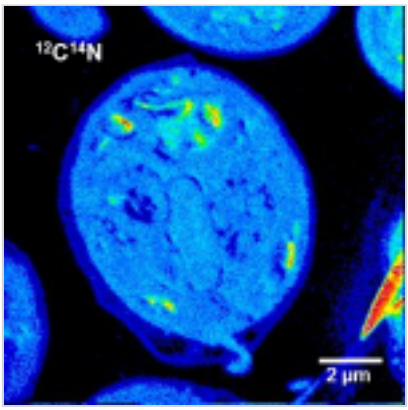
NanoSIMS

Imaging of chemical elements at nanometer level



As part of the EQUIPEX project MARSS, UPPA acquired a NanoSIMS, a top-level analytical instrument for chemical imaging at nanometer scale.

Metals and metalloids play a key role in many fields of our modern industrial societies. Not only as basic material in many industrial products, but also as trace elements and minerals in industrial processes, in the environment and in living organisms. Thus knowledge on chemical elements, such as metals, is directly related to scientific and technical progress, industrial development and economic growth as well as environmental and health aspects. An important issue is to evaluate the reactivity of metals in industrial processes, their transport in the environment or their essentiality and toxicity in organisms.

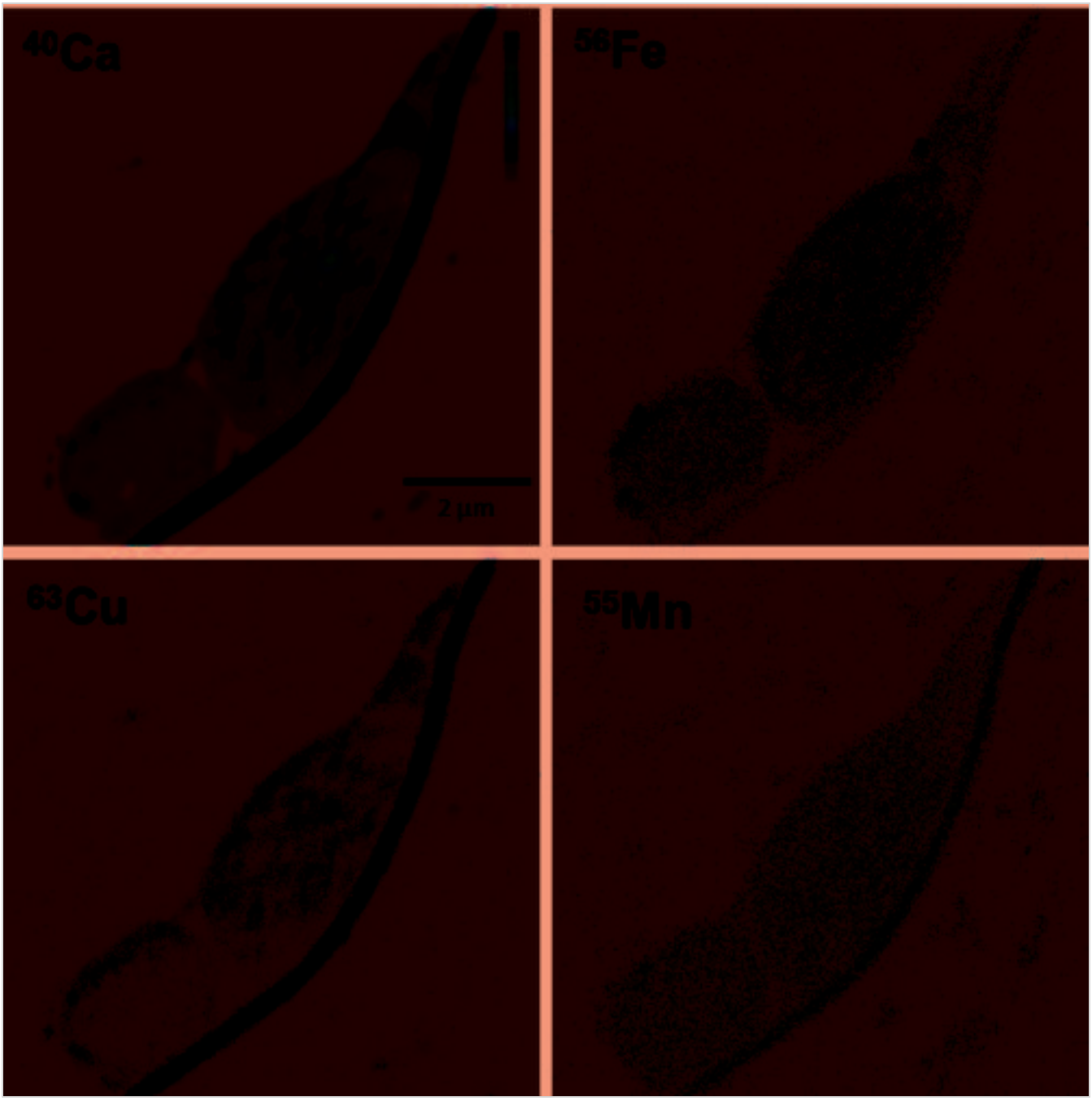
Nitrogen distribution in an algae cell

In this context, a key question is: *“What is the nanometric distribution of chemical elements at the surface of a sample?*”

In different scientific and technical disciplines chemical imaging at nanometer level can help to understand fundamental aspects and thus contributing, for example, to the improvement of industrial processes, to the protection of the environment, or to the development of new therapies.

Nano Secondary Ion Mass Spectrometry (NanoSIMS) allows imaging of chemical elements at a sample surface with high spatial resolution down to 40 - 50 nm combined with high sensitivity. NanoSIMS imaging is perfectly suited to measure and visualize the distribution of almost all elements in the periodic table - from hydrogen to uranium - including their stable isotopes. The parallel detection of seven elements or isotopes is possible. For some elements it can detect concentrations at the low ppm level. Thus, the NanoSIMS can be described as a scanning ion microprobe, or a “chemical microscope”, which can analyze at the sub-micrometer scale and produce elemental and isotopic images in 2D and 3D. Since its introduction in the 1990s, the high spatial resolution of the NanoSIMS opened numerous new research possibilities moving forward the frontiers of knowledge in different fields such as microbiology and cell biology, geology and space science as well as material research. Worldwide, about only 40 instruments are installed, mainly in academic research laboratories.

The NanoSIMS acquired by UPPA in frame of the EQUIPEX project MARSS is a unique instrument because it is equipped with a new oxygen primary ion source. This new ion source allows especially the detection of many different metals with high resolution (40 nm) and high sensitivity. This is not possible with other NanoSIMS instruments equipped with conventional ion sources. This newly developed oxygen ion source has been installed, tested and validated at the NanoSIMS of UPPA in collaboration with the NanoSIMS constructor CAMECA opening new, unique research possibilities e.g. for the localization of metals at catalyst surfaces or the imaging of essential and toxic trace metals in biological cells. First impressive results show for example the nitrogen distribution in an algae cell or the distribution of metals essential for photosynthesis in the chloroplast of a plant cell: calcium and the trace metals iron, copper and manganese. The latter results were obtained by the new oxygen ion source.



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