225

Laser ablation-ICP-MS as an alternative method to determine spatially resolved and quantitatively the organ burden directly in histological sections

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Nowadays nanomaterials (NMs) are essential for a variety of applications and therefore their production volume along with their pollution into the environment is rapidly increasing. To access potential risks to organism, animal testings still remain a necessity in regulatory toxicology. However, the development of novel analytical tools and strategies can help to reduce the number of animals.

Whenever adverse reactions are found in the organs of NM-treated animals, additional animals are required to determine their organ burden. For this purpose, inductively coupled plasma-mass spectrometry (ICP-MS) or optical emission spectroscopy (OES) after digestion protocols are utilized. But these results are limited to the bulk concentration of NMs within the respective organ whereas spatially resolved information are lost. In contrast, laser ablation (LA)-ICP-MS provides spatially resolved and quantitative information of elements directly in histological sections without the need of additional animals.

In this study, we used LA-ICP-MS with matrix-matched gelatine standards to quantify various elemental distributions in different organs derived from animal testings on NMs. The developed method was validated by an interlaboratory comparison of the quantitative iron distribution in spleens from different aged rats, showing that it is independent of the sample thickness and sample preparation procedure. Furthermore, the quantitative NM distribution of samples after a short-term inhalation of ZnO NPs and samples after a long-term inhalation of CeO_2 are in good agreement to organ burden calculations by organ digestion of additional animals. Our data indicate that LA-ICP-MS is a promising method to quantify NMs in histological sections without the need of additional animals.