Supplementary Information

S1 The basic theory of the universal ID method.

The intensities of production ions, which are produced from the reaction between an analyte of a monoisotopic element and a labelled reaction gas in the DRC of ICP–MS, are measured with and without a third element in the universal ID method, although the different isotopes are measured in the conventional ID method.

The typical measurement results are shown in the left figure, where the upper is measured without a third element and the below with a third element. In the case of As determination, As\(^{+}\)CH\(_2\), As\(^{+}\)CD\(_2\) and As\(^{+}\)CD\(_2\) + Zr\(^{+}\) are measured, so the signal intensities are expressed as [As\(^{+}\)CH\(_2\)], [As\(^{+}\)CD\(_2\)] and [As\(^{+}\)CD\(_2\) + Zr\(^{+}\)]. It is assumed that the amount of As in a sample is X, the amount of As contained in As\(^{+}\)CD\(_2\) is x\(_1\), the amount of As in As\(^{+}\)CH\(_2\) is x\(_2\), and the amount of Zr is M. The conversion efficiency of As to As\(^{+}\)CH\(_2\) and As\(^{+}\)CD\(_2\) is a constant under the constant conditions. Therefore, the intensity ratios measured are expressed by the equation (i) and (ii). Similarly, the intensity ratios between the x\(_1\) and x\(_2\) (Figure a)) and the x\(_1\)+M and x\(_2\) (Figure b)) are expressed by equation (iii) and (iv).

\[
\frac{[\text{As}]}{[\text{As}^{+}\text{CD}_2]} = \frac{X}{x_1} = R_x \quad \text{...equation (i)}
\]

\[
\frac{[\text{As}^{+}\text{CH}_2]}{[\text{As}^{+}\text{CD}_2]} = \frac{x_2}{x_1} = R' \quad \text{...equation (ii)}
\]

\[
\frac{[\text{As}^{+}\text{CH}_2]}{[\text{As}^{+}\text{CD}_2 + \text{Zr}^{+}]} = \frac{x_2}{x_1 + M} = R \quad \text{...equation (iii)}
\]

Then, the As concentration, X, is derived as follows:

\[
\frac{R x_1}{x_1 + M} = R \quad \text{...equation (v) (from equation (iii) and (iv))}
\]

\[
x_1 = \frac{R}{R'-R} M \quad \text{...equation (vi)}
\]

∴ \[
\frac{x}{x_1} = \frac{R}{R'-R} M \quad \text{...equation (vii) (from equation (ii))}
\]

Finally, X is calculated from equation (viii)

\[
X = \frac{R R_x}{R'-R} M \quad \text{...equation (ix)}
\]