



**CERTIFICATE**  
**ISOTOPIC REFERENCE MATERIAL IRMM- 654**

**$146.098 (48) \cdot 10^{-9} \text{ mol } (^{68}\text{Zn}) \cdot \text{g}^{-1} (\text{solution})$**

The Isotopic Reference Material is supplied with an isotope amount content of  $^{68}\text{Zn}$  certified as above.

The amount of zinc isotopes present are related to the  $^{68}\text{Zn}$  content through the following certified amount ratios:

$n(^{64}\text{Zn})/n(^{68}\text{Zn})$ :	0.003 489 4(38)
$n(^{66}\text{Zn})/n(^{68}\text{Zn})$ :	0.003 186 8(46)
$n(^{67}\text{Zn})/n(^{68}\text{Zn})$ :	0.001 411 3(17)
$n(^{70}\text{Zn})/n(^{68}\text{Zn})$ :	0.000 194 98(78)

This corresponds to an isotopic composition with the following abundances:

amount fraction ( $\cdot 100$ )		Mass fraction ( $\cdot 100$ )	
$n(^{64}\text{Zn})/n(\text{Zn})$	0.346 07(37)	$m(^{64}\text{Zn})/m(\text{Zn})$	0.325 81 (35)
$n(^{66}\text{Zn})/n(\text{Zn})$	0.316 06(45)	$m(^{66}\text{Zn})/m(\text{Zn})$	0.306 86 (44)
$n(^{67}\text{Zn})/n(\text{Zn})$	0.139 97(17)	$m(^{67}\text{Zn})/m(\text{Zn})$	0.137 96(17)
$n(^{68}\text{Zn})/n(\text{Zn})$	99.178 56(83)	$m(^{68}\text{Zn})/m(\text{Zn})$	99.209 45(79)
$n(^{70}\text{Zn})/n(\text{Zn})$	0.019 338(77)	$m(^{70}\text{Zn})/m(\text{Zn})$	0.019 914(80)

The molar mass of the zinc in this sample is  $67.903\,689\,(24) \text{ g} \cdot \text{mol}^{-1}$

From the certified values, the following amount content and mass contents are derived:

$147.308 (49) \cdot 10^{-9}$	$\text{mol (Zn)} \cdot \text{g}^{-1} (\text{solution})$
$9.923\,7 (33) \cdot 10^{-6}$	$\text{g } (^{68}\text{Zn}) \cdot \text{g}^{-1} (\text{solution})$
$10.002\,7 (33) \cdot 10^{-6}$	$\text{g (Zn)} \cdot \text{g}^{-1} (\text{solution})$

## NOTES

1. The isotope amount content value and the isotopic ratios of this Isotopic Reference Material are traceable to the SI in the shortest possible way via metrological weighings and via IRMM-652, IRMM-653 and IRMM-1007/1. Measurements calibrated by this Isotopic Reference Material have therefore the potential of being traceable to the SI (mole).
2. All uncertainties indicated are expanded uncertainties  $U = k \cdot u_c$  where  $u_c$  is the combined standard uncertainty estimated following to the ISO/BIPM Guide to the Expression of Uncertainty in Measurement<sup>1</sup>. They are given in parentheses and include a coverage factor  $k=2$ . They apply to the last two digits of the value. The values certified are traceable to the SI.
3. The IRMM-654 has been prepared from diluting a vacuum distilled shot. The IRMM-654 comes in a flame sealed quartz ampoule containing about 0.74  $\mu\text{mol}$  Zinc in 5 mL of a chemically stable nitric acid solution. The molarity is about 0.5M. Details of the preparation and certification procedure can be found in<sup>2</sup>.
4. The atomic masses used in the calculations are<sup>3</sup>:
 

<sup>64</sup> Zn:	63.929 142 2 (14)
<sup>66</sup> Zn:	65.926 033 4 (20)
<sup>67</sup> Zn:	66.927 127 3 (20)
<sup>68</sup> Zn:	67.924 844 2 (20)
<sup>70</sup> Zn:	69.925 319 3 (42)
5. All metrological weighings required in the preparation and certification were done by F. Hendrickx. The isotope abundance ratio measurements of the IRMM-651 were done by E. Ponzevera, using Multiple Collector Inductively Coupled Plasma Mass Spectrometry (MC-ICPMS). M. Berglund and C. Hennessy co-ordinated the preparation of this Isotopic Reference Material and G. Van Baelen was responsible for ampouling. C. Quétel co-ordinated the work leading to the certification of this Isotopic Reference Material and A. Verbruggen was responsible for issuance of the certificate.

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IRMM Isotope Measurements

<sup>1</sup> International Organisation for Standardisation, Guide to the Expression of Uncertainty in Measurements, Geneva, Switzerland 1995.

<sup>2</sup> Mass discrimination during MC-ICPMS isotopic ratio measurements: investigation by means of synthetic isotopic mixtures (IRMM-007 series) and application to the calibration of natural-like zinc materials (including IRMM-3702 and IRMM-651). Ponzevera *et al.*, Journal of the American Society for Mass Spectrometry, 2006. 17: p. 1412-1427.

<sup>3</sup> The 2003 atomic mass evaluation: (II). Tables, graphs and references. Audi *et al.*, Nuclear Physics A, 2003. 729(1): p. 337-676. Atomic masses used in <sup>2</sup> above come from an older reference (Isotope abundance variations of selected elements, Coplen *et al.* Pure Appl. Chem., Vol. 74, 10, pp1987-2017, 2002). This difference has impact only on last decimal of the calculated molar mass and no impact on Zn isotope ratios, amount and mass fractions.