Searching for an invariant of the sample composition in the measurement of the amount of substance

Hong Yi
National Institute of Metrology, China

Abstract: The measurement of the amount of substance implies the determination of the number of elementary entities of a sample at the microscope scale. The determination of a sample composition means the measurement of the amount of chemical elements. A central question for the measurement of the chemical composition is to search for the true value of a sample composition in the chemical measurement process at both the microscopic and macroscopic scales. The true value of the analyte element composition of a sample is defined the ratio of the number of atoms of the analyte element to the total number of atoms of all elements.

We found that the true value of a sample composition exists in any subsample of a homogeneous molecular population of the sample. At the molecular level we defined the homogeneity of a sample composition, i.e. the "homogeneity of the sample molecular population" is defined as "the closeness of agreement between a sample molecular population and the homogeneous molecular population of a sample". Based on the homogeneous molecular population axiom in which the molecular composition is identical for any homogeneous subsample, and combined with a homogenization thought experiment, we proposed and proved the Central Law of Measurement of the Amount of Substance: "The homogeneity of a sample molecular population represents the measurement accuracy of the sample composition in an analytical procedure".

In fact, the true value of the amount-of-substance fraction of an element exists in the entire molecular population of the sample as well as in any homogeneous molecular population of the sample. We recognized that the true value of a sample composition is an invariant for the homogeneous molecular population of the sample. The Central Law of Measurement of the Amount of Substance tells us whether or not a sample is a homogeneous molecular population after the sample is chosen. To obtain the true value of a sample composition, we must measure all the molecules of the sample, or homogenize the sample at the molecular level and maintain this homogeneity in every measurement procedure. In this way, we can measure a sample composition with the highest accuracy at both the microscopic and macroscopic scales. Accordingly, an accurate composition measurement process should also be a sample homogenization process. Chemical composition measurements actually reflect one's capability to manipulate and identify the sample molecules.