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The ‘RM family’—Identification of all of its members

Received: 4 September 2005
Accepted: 23 September 2005
Published online: 22 February 2006
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Abstract Subgroups of reference materials are briefly outlined based on accompanying information and crucial material characteristics for their application. It is proposed to include, besides the certified reference materials, calibrants and so-called quality control materials under the family name ‘reference materials’.

Keywords Reference materials · Classification · Terminology

Introduction

There exists still considerable ‘uncertainty’ about the proper selection and use of reference materials (RM) for various applications in quality assurance and quality control of measurements. Part of the confusion seems to originate from the multitude of terms used in the various analytical/measurement communities and the different understanding of underlying concepts. The close relation between the intended use for an RM in a given measurement procedure and the required material characteristics for various purposes has been discussed, for instance, in a recent paper [1].

Moreover further contributions for terminology clarification and systematic classification are stimulated by ongoing discussions about the revision of the VIM [2] and other attempts towards a more harmonised application of terms and their common understanding among scientists (and their ‘assessors’ and ‘funding bodies’), but also in communications with legislators/regulators and industry.

RM subgroups

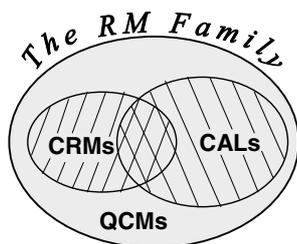
The recently released new definition of the term ‘reference material’ states that an RM is a “material, sufficiently homogeneous and stable with respect to one or more specified properties, which has been established to be fit for its intended use in a measurement process. NOTE 1: RM is a generic term. NOTE 2: Properties can be quantitative or

qualitative, e.g., identity of substances or species. NOTE 3: Uses may include the calibration of a measurement system, assessment of a measurement procedure, assigning values to other materials, and quality control. NOTE 4: An RM can only be used for a single purpose in a given measurement” [3]. The first note highlights specifically the fact that the term ‘reference material’ is a family name. Who are the members of this family?

The answer is illustrated in Fig. 1. Obviously, all materials fulfilling the characteristics of adequate homogeneity and stability required for quality control of a given measurement belong to the RM family (grey ellipse in Fig. 1). The ones which are not accompanied by a certificate are often called non-certified reference materials. But many other terms such as in-house materials, laboratory control materials, laboratory reference materials are also used. Here the term “Quality Control Material (QCM)” is favored for this subgroup of RMs which fulfill only the characteristics of homogeneity and stability fit for the intended use. They may support one or more applications from the wide range of both internal and external quality control measures. But they are not sufficiently characterized to be used for method calibration or to provide metrological traceability of a measurement result.

Another subgroup of RMs is formed by the certified reference materials (CRMs) depicted in a special ellipse in Fig. 1. They are now [3] defined as “reference material, characterized by a metrologically valid procedure for one or more specified properties, accompanied by

Fig. 1 The RM family (QCM ... quality control material, CRM ... certified reference material, CAL ... calibrant)



a certificate that provides the value of the specified property, its associated uncertainty, and a statement of metrological traceability. NOTE 1: The concept of value includes qualitative attributes such as identity or sequence. Uncertainties for such attributes may be expressed as probabilities. NOTE 2: Metrologically valid procedures for the production and certification of reference materials are given in, among others, ISO Guides 34 and 35. NOTE 3: ISO Guide 31 gives guidance on the contents of certificates.” That means a reference material belongs to this group if it comes on top of the QCM characteristics with a certificate, a certified value with its uncertainty and a stated metrological traceability. Further details about these minimum quality characteristics of CRMs are explained in the corresponding ISO Guides [3–5].

The other RM family members are the materials used for calibration (indicated by another special ellipse in Fig. 1). Interestingly enough, they are often not explicitly recognized as “reference materials”. Products traditionally called ‘analytical standard,’ ‘calibration standard’, etc. are frequently seen as being outside of the RM family or as having a “higher metrological order” than CRMs. But this misperception originates only from a mixing of classification systems. Basically calibration materials have to be sufficiently homogeneous and stable as to ensure that the assigned property value and its uncertainty are valid for any calibration sample used according to the given specifications. Therefore, they fall under the RM definition given above. Here the term “calibrant (CAL)” is used for such materials. The latest available draft version of the VIM in revision [P. De Bièvre, personal communication] proposes the word ‘calibrator’ for a “measurement standard used in the calibration of a measuring system”. But the term ‘calibrant’ is much wider used, at least in analytical chemistry, also for avoiding confusion with the person performing the calibration or to distinguish between a material (chemical substance) and a device used for calibration (mainly in physics).

The necessary additional features of a calibrant in comparison to QCMs are a stated property value with an uncertainty useful for calibration and metrological traceability of the property value. These characteristics are not always completely fulfilled by various materials nowadays used for calibration in different measurement communities or laboratories. But that means only that insufficiently characterized materials are used for this purpose and it does not invalidate the principally required minimum quality characteristics for calibrants, in particular with respect to known uncertainty and traceability of the value used for calibration.

It seems to be acceptable that no formal “certificate”, which provides the comprehensive information specified in ISO Guide 31 for CRM certificates [4], is available for many calibrants used in analytical laboratories. Therefore, only part of the calibrants can be called CRMs and a separate ellipse had to be created in Fig. 1. On the other hand a significant number of existing CRMs is accompanied on their certificates by stated uncertainties of their property values, which make them useful for quality control or other CRM applications, but not for calibration. This does not disqualify them as CRMs in general (see CRM definition above), but it simply restricts their range of application. A review of CRM catalogues shows that the stated uncertainties of certified property values for several matrix CRMs, but also for various so-called pure substance CRMs or their solutions, are too large for a useful calibration of measurement instruments or systems. Consequently, only that part of CRMs which provide on their certificates uncertainties of property values fit for calibration of the intended measurement method would belong both to the CRM and the CAL groups as shown in Fig. 1 by the overlapping region.

Conclusion

The recognition of the term ‘reference material’ as a family name calls for commonly understood and used terms for the various RM subgroups which may be distinguished by minimum material characteristics and accompanying information important for their QA/QC applications. It should be generally recognized that calibrants belong to the reference materials. It is proposed to call an RM, which is coming without stated uncertainty and metrological traceability and possibly even without a property value to the user laboratory, quality control material (QCM).

References

1. Emons H, Linsinger TPJ, Gawlik BM (2004) Trends Anal Chem 23:442–449
2. BIPM-IEC-IFCC-ISO-IUPAC-IUPAP-OIML (1993) International Vocabulary of Basic and General Terms in Metrology (VIM), 2nd edition, ISO, Geneva
3. International Organization for Standardization (2005) ISO Guide 35: Reference Materials – General and statistical principles for certification, revision of 3rd edition, ISO, Geneva
4. International Organization for Standardization (2000) ISO Guide 31: Reference Materials – Contents of certificates and labels, 2nd edition, ISO, Geneva
5. International Organization for Standardization (2000) ISO Guide 34: General requirements for the competence of reference material producers, 2nd edition, ISO, Geneva