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Book review

**Thermodynamic stability of radioactivity standard solutions. Marie-Gabrielle Iroulart, Monographie BIPM-6, Bureau International des Poids et Mesures, Pavillon de Breteuil, F-92310 Sèvres, France, ISBN 92-822-2220-9**

This monograph is an appropriate and appreciated addition to a small series published by the Bureau International des Poids et Mesures (BIPM) on behalf on the Comité Consultatif des Rayonnements Ionisants (CCRI). The aim of the series is to review important topics in the measurement of radioactivity, particularly for information relevant to the techniques used by the National Metrology Institutes (NMI) of various nations and for participants in international measurement comparisons. Previous topics in the series consisted of: (1) procedures for accurately diluting and dispensing radioactive solutions; (2) detection and estimation of spurious pulses; (3) application of liquid scintillation counting to radionuclide metrology; (4) activity measurements with ionization counters; and (5) a three-volume table of decay data for selected radionuclides with extensive comments on the data evaluations. This volume, along with its companions in the series, belongs on the bookshelf (or as a website bookmark) of every serious radionuclidic metrologist.

Monographie BIPM-6 is available, in its entirety, online at: http://www.bipm.fr/utils/common/pdf/monographieRI/Monographie_BIPM-6.pdf and is based on an earlier paper by the same author under the same title [Appl. Radiat. Isot. 64, 1265–1270 (2006)]. The paper was substantially expanded with much more detail for the monograph. The monograph is divided into two main sections: viz., chemical properties of solutions; and method of preparation, packaging and storage. The former contains an excellent summary of the characteristics of ultra-pure water and a discussion of the role of acid and carrier ion concentrations. The latter section firstly addresses the structure of glass and the types currently in use at NMIs and at BIPM, then considers the dissolution mechanisms of glass under the influence of various reagents, and finally treats extensively the sorption of cations and anions at the solid–solution interface inside a glass vessel. The section concludes with some insights on cleaning and packaging of glass ampoules.

After having dealt with the practical issue of radioactive solution stability in various capacities for the better part of the past 35 years, I suspect what most surprised me on my first reading of the monograph was: (i) how many simple, basic facts about glass I was unaware of; (ii) how many misconceptions I had about some of the mechanisms that can lead to solution instability; and (iii) how much I learned. For example, as one of the principals responsible for specifying, selecting, and ultimately accepting the NIST/BIPM (SIR)[1] standard ampoules in 1976. I was somewhat disconcerted to discover that our laboratory had never correctly identified or described the type of glass used in our "lifetime" supply of ampoules. More importantly, this monograph helped me to truly appreciate the important role of the solvent at the glass–solution interface, instead of just focusing on stable oxidation states and the active/inactive carrier ion ratios.

This monograph's main disappointment was that it focused primarily on the properties of glass and on glass–solution interactions; and, as a result, failed to address many of the practical aspects of maintaining stable standard solutions for many years, if not many decades. A colleague of mine correctly noted that the issues and problems "are not the same for glass containers used for radioactive waste and for standard solutions." The suggestion, for example, of the possible adequacy of using solutions of metallic cations in mineral acid concentrations as low as $0.1\,\mathrm{mol\,L^{-1}}$ (in contradistinction to the common practice of using $>1\,\mathrm{mol\,L^{-1}}$) is unlikely to be judicious except for solutions of very short-lived radionuclides. In addition, it is apparent that the document is limited by its overly parochial reliance, as examples, on only the procedures used by the Laboratoire National Henri Becquerel (LNHB). The documentation collected for the monograph would have been decidedly strengthened by surveying and incorporating the laboratory practices, experiences, and relevant references used at other NMIs. For example, the need to sterilize some radioactive solutions was not addressed in the monograph, yet it is a common practice at NIST for very dilute solutions of long-lived radionuclides that are intended to be stored in glass ampoules for many years. The removal of metal ions from radioactive solutions by microscopic fungi and algae is well known, and their presence will also interfere with any gravimetric mass determinations. A low-level standard solution of a $^{14}$C-labelled organic compound, without a

[1]The ampoules used by BIPM and other laboratories for the international reference system (SIR) were donated to BIPM by the National Institute of Standards and Technology (NIST) and were randomly selected from the same special batch of ampoules obtained by NIST in 1976 from the former Kimble Glass, Inc. (USA).

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preservative or sterilization, is likely to result in the release of labeled $CO_2$!

The monograph concluded by identifying the need for additional studies, including the development of a reference document, to be drawn up by LNHB, on the chemical compositions to be used for preparing stable radioactive standard solutions. Such an important endeavor would benefit from the collective experience and wisdom of laboratory workers at other NMIs. In fact, this kind of tabulation has been in existence at NIST for at least 50 years and its most current version is available in NCRP report no. 58, second edition (National Council on Radiation Protection and Measurements, Bethesda, MD, USA, 1985).

The above reservations should not detract from my belief in the monograph's usefulness and importance as a first step in addressing the issue of standard solution stability.

The views expressed here are those of the reviewer and not necessarily those of the National Institute of Standards and Technology.

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