



# National Institute of Standards & Technology

## Certificate

### Standard Reference Material 4990C Oxalic Acid

### International Standard Reference Material for Contemporary Carbon-14

This Standard Reference Material (SRM) consists of a 227-gram (one-half-pound) portion of a 455-kilogram (1000-pound) lot of oxalic acid prepared by fermentation of French beet molasses, from the 1977 spring, summer, and autumn harvests, using *Aspergillus niger var.*

The mass spectrometric ratio of carbon-13 to carbon-12 in this material, and the corresponding ratio in the old contemporary carbon-14 standard, SRM 4990, were measured by thirteen international carbon-dating laboratories. Measurements by twelve laboratories show that the ratio of carbon-13 to carbon-12 is slightly greater in the new standard. The difference in  $\delta^{13}\text{C}$  is  $(1.49 \pm 0.05)$  per mil, where the uncertainty is one estimated standard deviation.

The ratio of the carbon-14 massic activity [a]\* in the new material, SRM 4990C, to that in the old material, SRM 4990, was also measured by nine of the thirteen laboratories. The unweighted mean of the individual weighted-mean results for this ratio, normalized to  $\delta^{13}\text{C}$  values of -19.3 per mil for the old standard and -17.8 per mil for the new standard, is  $1.2893 \pm 0.0004$ . The weighted mean of the individual weighted-mean results, similarly normalized, is  $1.2933 \pm 0.0004$ . The uncertainties of each of these results is one estimated standard deviation of the mean value. Using the method of Paule and Mandel [2], the weighted mean of the weighted results is 1.2931 with one estimated standard deviation of the mean equal to 0.0005, and one estimated standard deviation between laboratories equal to 0.0008 [b].

Uncertainties can arise in the determination of the plateau threshold of a proportional counter, and in the measurements of pressure and temperature in the gas-handling systems. An estimate of the sum of these uncertainties in any measurement is on the order of 0.15 percent. Different uncertainties arise in liquid-scintillation counting systems. In this group of massic activity measurements from nine participating laboratories, these other uncertainties from laboratory to laboratory have a reasonable probability of being normally distributed. No account has therefore been taken of uncertainties arising from sources other than counting statistics, in weighting the results submitted by the participating laboratories. The contribution of these other sources of uncertainty may be on the order of 0.05 percent.

This Standard Reference Material was calibrated in an international comparison organized by L.M. Cavallo and W.B. Mann in the Center for Radiation Research, Nuclear Radiation Division, Radioactivity Group. A detailed report of this comparison has been published in *Radiocarbon* [3].

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## NOTES

- [a] **Massic activity** is the preferred name for the quantity activity divided by the total mass of the sample. See reference [1].
- [b] At the 1982 11th International Radiocarbon Dating Conference in Seattle there was a consensus in favor of adopting the weighted mean of the weighted individual results, 1.2933, for the massic activity ratio of the new to the old NBS oxalic acid standards. Furthermore, 0.7459 times the massic activity of the new standard when normalized to a  $\delta^{13}\text{C}$  value of -25 per mil is equal to 0.95 times the massic activity of the old standard normalized to a  $\delta^{13}\text{C}$  value of -19 per mil. A more extensive discussion is given in reference [4].

## REFERENCES

- [1] International Organization for Standardization (ISO), *ISO Standards Handbook - Quantities and Units*, 1993. Available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, U.S.A. 1-212-642-4900.
- [2] R.C. Paule and J. Mandel, Consensus Values and Weighting Factors, *NBS J. Research* **87** (1982) 377.
- [3] W.B. Mann, New Contemporary Radiocarbon-Dating Standards, in Proceedings of the 1982 11th International Radiocarbon Dating Conference, M. Stuiver and R. Kra, editors, *Radiocarbon* **25**, No. 2 (1983) 519.
- [4] M. Stuiver, International Agreements and the Use of the New Oxalic Acid Standard, in Proceedings of the 1982 11th International Radiocarbon Dating Conference, M. Stuiver and R. Kra, editors, *Radiocarbon* **25**, No. 2 (1983) 793.