U.S. Department of Commerce
Juanita M. Kreps
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards Certificate

Standard Reference Material 2601

Crystalline $Al_2O_3:Cr^{3+}$ (Ruby)

Electron Paramagnetic Resonance Absorption Intensity Standard

T. Chang and A. H. Kahn

This Standard Reference Material is intended for use in electron paramagnetic resonance (EPR) measurements for determining the number of active paramagnetic centers in a test sample. The set supplied is in the form of two pieces of synthetic ruby that were cut from a single boule grown by the Czochralski process. One is a square plate of nominal size 1.5 x 1.5 x 0.5 mm; the other is a bar of nominal size 0.5 x 0.5 x 4 mm. For the plate-like sample the c axis is normal to the plane of the plate; for the bar-like sample the c axis is parallel to the long dimension.

The concentration of Cr^{3+} ions in the original boule, obtained by static magnetic susceptibility measurements, was found to be $(3.694 \pm 0.011) \times 10^{15}$ ions/mg. The uncertainty quoted is the standard deviation of the mean computed from six measurements. The mass of each sample in this set and the number of Cr^{3+} ions in each sample are given in the following table. The uncertainties quoted are standard deviations which arise from the weighing of the samples.

SRM 2601 Set No.	Mass of Sample	Number of Cr^{3+} Ions
Plate-like Sample	mg ± 1%	x 10^{15} ± 1%
Bar-like Sample	mg ± 1%	x 10^{15} ± 1%

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by R. K. Kirby.

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J. Paul Cali, Chief
Office of Standard Reference Materials

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Packaging

The two samples comprising this SRM set are packed separately in translucent polyethylene vials. The vials are contained in a transparent plastic bottle to which an identifying label is affixed. The original packaging provides convenient storage.

Inspection and Handling

The two SRM samples may be identified visually while they are in the vials. As the samples are small and translucent, they are easily lost. Careful handling with fine tweezers under adequate lighting is recommended.

Method of Use

The use of this SRM is discussed in detail in NBS Special Publication 260-59. In this publication, the magnetic fields, transition probabilities, and integrated intensities are tabulated for resonance transitions at microwave frequencies from 6 to 50 GHz and at various orientations of the crystalline c axis with respect to the applied magnetic field. A brief description of the method is as follows:One of the SRM samples and a test sample are placed adjacent to each other in the microwave cavity of an EPR spectrometer. The profiles of the derivatives of the EPR absorption of a certain transition from the SRM and the test sample are recorded. The area under each of the absorption curves is obtained by double integration. The number of active spins in the test sample is calculated from the ratio of these areas. It is necessary that the orientation of the SRM and the test sample be known. The species of the active centers and the related parameters must also be known, and the resonance line width should be moderately narrow, typically 8000A/m (100 Oe) or less. The determination of the number of spins will have an expected accuracy of $\pm 10\%$. This limitation is imposed by the current state-of-the-art reproducibility of EPR experiments.