ZERO-GRADIENT PLANAR HEATER FOR MÖSSBAUER EFFECT EXPERIMENTS

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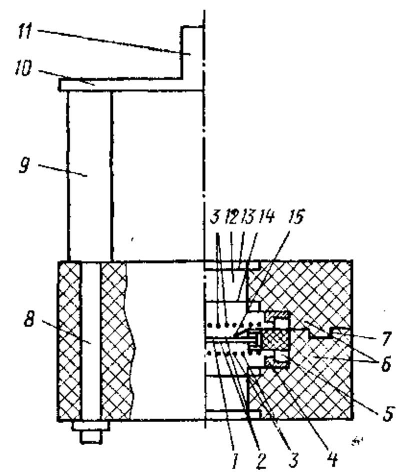
The temperature chambers for Mössbauer-effect experiments must be able to cover the required temperature range, be capable of establishing the necessary temperature sufficiently rapidly and holding it with the necessary stability during the experiment, provide minimal temperature gradients in the sample, and be compatible with the experimental geometry and the passage of an adequate radiation flux, all without damaging the sample.



Miniature vacuumless oven with a planar heater. 1) Sample; 2) beryllium disk; 3) heater elements; 4) brass rings; 5) asbestos cement spacers; 6) oven body; 7) recess; 8) bolts; 9-11) apparatus for attachment to vibrator shaft; 12) aperture for γ rays; 13, 14) beryllium windows; 15) thermocouple bank.

The ovens which have been described in the literature either have a large dimension in the γ propagation direction or cannot be used with large samples without establishing temperature gradients in the samples [1, 2]. Below we describe a zero-gradient planar heater for high-temperature ovens for transmission-setup Mössbauer experiments [3].

The sample (1) is held tightly by guides and plates of heat-resistant chrome-nickel alloy between beryllium disks (2).

Some distance from the beryllium disks there is a series (3) of parallel, uniformly stressed thin wires of high-resistivity refractory material (in our case Nichrome or tungsten, 0.1-0.2 mm in diameter). The spacing of these wire filaments and the separation between their plane and the beryllium disks holding the sample are chosen empirically; these dimensions depend on the filament diameter, the sag of the filaments which would occur during heating, because of the increase in filament length due to thermal expansion is eliminated by the tension established beforehand and is automatically compensated during the heating through a matching of the thermal-expansion coefficients of the filament materail and the material in the oven body.

A vacuumless, fast-response, zero-gradient chamber of this type with a Nichrome heater has been used satisfactorily at temperatures of up to ~700°C.

The heater filament is stretched on a brass ring (4) and is insulated from it by asbestos cement spacers (5).

The oven body is made in two parts (6), from asbestos cement; recess (7) is used to help position the parts of the body and to ensure a close fit when bolts (8) are tightened. The bolt heads are embedded in thin-walled stainless steel tubes (9), attached to an arm

(10) with a chuck (11) for mounting on the shaft of a vibrator. Through apertures (12) in the oven body are covered with beryllium windows (13, 14), held against the body by asbestos cement collars and cemented in place. The bank of chromel-alumel thermocouples (15) is separated from the beryllium disks with sample by only a thin mica spacer.

The temperature gradient along the sample diameter is measured by differential thermocouples placed, along with beryllium oxide as a "sample," between beryllium disks (2). The output voltage of the differential thermocouples did not exceed the experimental error of the R-306 potentiometer over the entire temperature range.

When a regulation system similar to that described in [3] is used, no broadening of the $\alpha-Fe_2O_3$ hyperfine lines is observed at 600°C within the reproducibility of the experimental spectrum (5% of the line width).

When the γ's pass through the furnace without the sample, 35% of the 14.4 kV radiation is lost. The sample diameter (20 mm) could be increased without any loss of uniformity in the heating of the sample.

The small size and weight of the chamber allow it to be vibrated by a laboratory electrodynamic vibrator.

REFERENCES

1. V. P. Alfimenkov, Yu. M. Ostanevich, A. V. Strelkov, B. Savitskii, L. U. Cher and Shi. Bay, JIN Preprint No. 13 [in Russian], p. 29-88, Dubna, 1966.
2. E. Van der Woude and G. Boom, Rev. Sci. Instr., 36, 800, 1965.
3. V. A. Golovnin, S. M. Irkaev, R. N. Kuz'min, and L. G. Chachkhiani, Pribory i tekhnika eksperimenta, no. 1, 111, 1969; R. N. Kuz'min, Doctoral Dissertation [in Russian], MGU, 1969.

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