POSTER

PRECISE INTERFERENCE DILATOMETER FOR DETERMINATION OF THE COEFFICIENT OF THERMAL EXPANSION OF CARBON MATERIALS

Vladimir I. Shuvalov, Vadim V. Mochalov
and Gennatul Kh. Tagabilev

Joint Stock Company "Ural Electrode Institute"
160 Pobedy Ave., Chelyabinsk 454084, Russia

INTRODUCTION

The linear coefficient of thermal expansion (CTE) is one of the most important properties of carbon materials determining their industrial value. The reliability of CTE determination depends greatly on the correct reflection of structure of the material under investigation.

The thermal expansion is affected by the following parameters:

1. Technological
a) coke particle size distribution,
b) quality and quantity of binder,
c) mixing and forming techniques,
d) heat treatment conditions on calcination, baking and graphitization.

2. Structural
a) degree of anisotropy,
b) pore size distribution,
c) impurity level.

3. Technical
a) shape and dimensions of sample,
b) initial and final temperatures.

All the above mentioned features should be taken into consideration in the method of the CTE determination, the technology of preparation, shape and dimensions of the sample.

The range (R) and accuracy (A) of the CTE determination by different dilatometric methods are given below:

1. Dilatometers with push rods
(R) $0.3 \cdot 10^{-6} \ldots 25 \cdot 10^{-6}$ K^{-1}
(A) $1.2 \cdot 10^{-7} \ldots 45 \cdot 10^{-7}$ K^{-1}

2. Comparators
(R) $0.3 \cdot 10^{-6} \ldots 25 \cdot 10^{-6}$ K^{-1}
(A) $1.2 \cdot 10^{-7} \ldots 45 \cdot 10^{-7}$ K^{-1}

3. Dielectric capacity dilatometers
(R) $0.05 \cdot 10^{-6} \ldots 25 \cdot 10^{-6}$ K^{-1}
(A) $0.3 \cdot 10^{-7} \ldots 15 \cdot 10^{-7}$ K^{-1}

4. Interference dilatometers
(R) $0.05 \cdot 10^{-6} \ldots 25 \cdot 10^{-6}$ K^{-1}
(A) $0.2 \cdot 10^{-7} \ldots 15 \cdot 10^{-7}$ K^{-1}

EXPERIMENTAL

The sample for dilatometric measurement is prepared in the form of a cylinder of 12 mm diameter, 100 mm length, the tips of the sample being hemispherical in shape. The interference method is chosen as the method, giving more advantages in the accuracy, simplicity and reliability of the CTE determination as well as in the simplicity of sample preparation.

The accuracy of the determination is provided by the use of the comparison method, where the sample holder is made of material with a well-established value of CTE. The use of several sample holders with different CTE values gave us an opportunity to measure CTE of different carbon materials in a wide range of CTE values with high accuracy.

The principal optical scheme of the interference dilatometer is similar to that described in (1). The light beam from a laser passes through the optical system, including beam widener, condenser, mirrors, diaphragms and screens, and falls on the sample holder and interference plate placed into the heater.

Reflecting from the top surface of the sample holder and the bottom surface of the interference plate, that form Fizeau interferometer, light beams create the interference image. This interference image is transformed into the registration channel. The top surface of the sample holder, being the second interference plate, should be polished to 1/20 of the monochromatic wave length to be used.

For precise measurements the angle between the top surface of the sample holder and the bottom surface of the interference plate should be changed in very narrow range from 3 to 6'. That is why the bottom hemispherical tip of the sample rests on a special regulating device, giving the opportunity to measure the CTE of the sample without its fitting to the length of the sample holder.

This regulating device also allows to coincide maximum or minimum of the interference band with zero-line of the scale, increasing the accuracy of measurements.

The sample is inserted into the holder and interference plate is placed on them. Zero-line is coincided with minimum of the interference band, the heater is closed and the process of the CTE determination goes automatically in accordance with a computer program.

Convenience and simplicity of the interference dilatometer enables to measure the CTE of carbon materials in the CTE range from $5 \cdot 10^{-8}$ to $25 \cdot 10^{-6}$ K^{-1} with the precision not less than $2 \cdot 10^{-8}$ K^{-1} in the temperature range from 30 to 300 °C.

The dilatometer is compact. It consists of two blocks (measuring and controlling), the total weight being not more than 25 kg (Figure 1).

The determination of the CTE of standard sample, made of special alloyed quartz glass ($\alpha_{30-100} = 0.30 \cdot 10^{-7}$ K^{-1}) has given the CTE value $0.29 \cdot 10^{-7}$ K^{-1}.

These interference dilatometers are successfully used at several Russian electrode plants for electrode and coke (including needle cokes) testing.

CONCLUSION

The precise interference dilatometer for the determination of the CTE of any solid carbon materials is worked out and installed in electrode plant laboratories. The dilatometer allows to measure the CTE from $5 \cdot 10^{-8}$ to $25 \cdot 10^{-6}$ K^{-1} with the precision not less than $2 \cdot 10^{-8}$ K^{-1} in the temperature range from 30 to 300 °C.

REFERENCES

1. W.A.Plammer and H.E.Hagy, "A High Precision Priest Interferometer", Proc. 6th Int. Symp., Hecla, Island, 1977, New York/London, 1978, Vol.6.

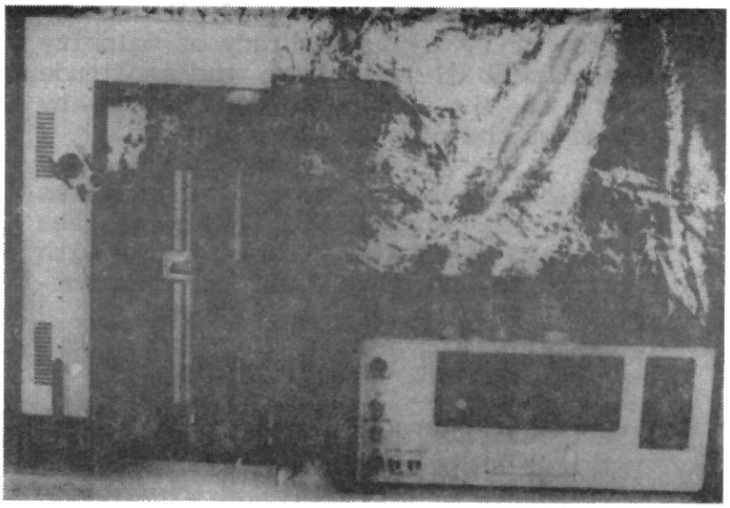

FIGURE 1: Precise interference dilatometer DID-1 (general view)