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Thermal Expansion of Strontium Tungstate

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Accurate lattice parameters of strontium tungstate, an isotype of scheelite, have been determined as a function of temperature by the X-ray powder method in the temperature range 28 to 355° C. Both the lattice parameters are found to increase with temperature. Using these data, the two coefficients of thermal expansion, α_a along the *a*-axis and α_c along the *c*-axis, have been calculated. The temperature dependence of the coefficients could be expressed by the following equations:

$\alpha_a = 5.88 \times 10^{-6} - 25.63 \times 10^{-10} T + 59.49 \times 10^{-12} T^2$

$\alpha_c = 13.20 \times 10^{-6} - 18.18 \times 10^{-10} T + 71.45 \times 10^{-12} T^2$.

Here T is the temperature in °C.

1. Introduction

A programme of investigations to determine the lattice and structural parameters of a few scheelite type crystals, in the high temperature range, has been undertaken in this laboratory. Results on the temperature variation of the lattice parameters and the thermal expansion of potassium metaperiodate [1] and sodium metaperiodate [2] have already been published. The present note gives the results of the precision determination of the unit cell dimensions of strontium tungstate ($SrWO_4$) at different temperatures between 28 and 355° C and also the principal coefficients of its thermal expansion obtained from these data, on which there has been no report available.

2. Experimental and Results

The sample of $SrWO_4$, used in this investigation, is from a synthetically grown crystal, kindly supplied by Dr W. S. Brower of National Bureau of Standards, Washington, DC. The X-ray powder photographs, at different temperatures, were taken employing a high temperature symmetrical focusing camera [3] and Cu K radiation. To get sharp lines in the high angle region, it was found necessary to anneal the substance at 800° C for about 20 h.

The α_1 and α_2 reflections from (536), (1.1.14), (624), (448), (4.0.12) and (5.1.10) planes, recorded in the Bragg angle region 66 to 77°, were used in evaluating the lattice parameters by Cohen's [4] method, in combination with an error function. The lattice parameters at different temperatures are given in table I.

TABLE I Values of the lattice parameters of strontium tungstate at different temperatures

Temp ° C	*a* Å	*c* Å
28	5.4183	11.9532
70	5.4202	11.9614
105	5.4220	11.9682
165	5.4231	11.9748
210	5.4249	11.9839
265	5.4273	11.9957
310	5.4294	12.0027
355	5.4326	12.0171

For the film taken at 28° C, the standard errors in the parameters were evaluated by the method of Jette and Foote [5]. These were found to be $\pm$ 0.0003 Å and $\pm$ 0.0008 Å in the *a* and *c* parameters respectively. The errors at higher temperatures were assumed to be of the same order.

Values of the two principal coefficients of expansion α_a and α_c at different temperatures were evaluated from the temperature/parameter plots by the method suggested by Deshpande

and Mudholkar [6] and the following expressions were obtained for their temperature variation:

$$\alpha_a = 5.88 \times 10^{-6} - 25.63 \times 10^{-10} T + 59.49 \times 10^{-12} T^2$$

$$\alpha_c = 13.20 \times 10^{-6} - 18.18 \times 10^{-10} T + 71.45 \times 10^{-12} T^2.$$

Here T is the temperature in ° C. The results are shown in fig. 1.

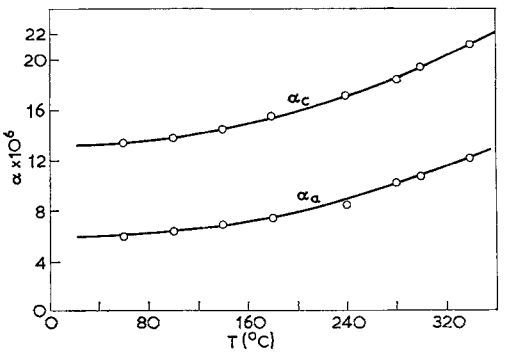

Figure 1 Temperature variation of the principal coefficients of thermal expansion of strontium tungstate.

The values of the two coefficients at 30° C are $\alpha_a = 5.86 \times 10^{-6}/°$ C and $\alpha_c = 13.21 \times 10^{-6}/°$ C. The mean coefficients of expansion over the range 30 to 355° C were found to be $\bar{\alpha}_a = 9.16 \times 10^{-6}/°$ C and $\bar{\alpha}_c = 17.38 \times 10^{-6}/°$ C.

The nature of the anisotropy in the thermal expansion of this crystal is the same as in other crystals of the scheelite group, namely $\alpha_c > \alpha_a$ at all temperatures. The differences between the thermal expansion behaviours of different crystals of this group, are being discussed in a detailed paper to be published elsewhere.

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