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Some Properties of Strontium Hydroxide and Its Monohydrate

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Strontium hydroxide, $Sr(OH)_2$, was prepared by hydration of strontium oxide under pressure at 400° C. The monohydrate was prepared by hydration of the oxide at 168° C. and also by evaporation of a boiling solution of strontium hydroxide. Optical properties and X-ray powder diffraction patterns are given.

1. Introduction

Strontium hydroxide, in the form of its octahydrate, $Sr(OH)_2 \cdot 8H_2O$, is a substance familiar to the chemist. Various lower hydrates have been postulated from time to time, but there seems to be little evidence of the existence of any except the monohydrate, $Sr(OH)_2 \cdot H_2O$. Dehydration studies by several investigators [1,2,3] [1] give fairly definite data concerning the dissociation of the octahydrate and of the unhydrated hydroxide.

Equations relating the dissociation pressures of strontium hydroxide and its octahydrate to temperature are given by Tamaru and Siomi [3]. From these equations, the temperature at which the dissociation pressure reaches 760 mm is calculated to be 92° C for $Sr(OH)_2 \cdot 8H_2O$ and 701° C for $Sr(OH)_2$. The shape of the dissociation curve indicates that a monohydrate exists, but its dissociation temperature is not clearly defined.

In view of the amount of work done on $Sr(OH)_2$ and its monohydrate, it is somewhat surprising that there appears to be no published data on the optical properties of these compounds. X-ray diffraction patterns were published by Hüttig and Arbes [1], but in such form that they are very difficult to translate in terms of interplanar spacings, or even to use as a basis for identification.

In connection with some hydrothermal studies of strontium compounds, it was necessary to be able to identify the various forms of the hydroxide. Accordingly, the hydroxide and its monohydrate were prepared, and their more useful identifying properties determined.

2. Procedure and Results

Strontium carbonate, reagent grade, was heated at 1,300° C to convert it to the oxide. The dry oxide was then exposed to water vapor in a pressure bomb at 400° C for 3 days. The product was a dry powder containing 0.98 mole of water per mole of SrO, closely approximating the composition of $Sr(OH)_2$. The crystals averaged about 20 μ in diameter, but were somewhat rounded and irregular, so that the ideal shape could not be determined. They appeared to be in the form of relatively thick plates. The crystals described were prepared with a moderate excess of water in the bomb. Reducing the water to the stoichiometric quantity resulted in crystals that were much smaller but of the same composition. The optical properties are as follows: Refractive indices, $\alpha=1.588$, $\beta=1.599$, and $\gamma=1.610$; character, biaxial; sign, positive; and optic axial angle 2V, nearly 90°.

Hydrothermal treatment of strontium oxide at 168° C, in the presence of a slight excess of water, resulted in a product having 1.95 moles of H_2O per mole of SrO, approximately the composition of $Sr(OH)_2 \cdot H_2O$. The crystals were larger than those described above but quite irregular in shape. The indices are $\alpha=1.570$, $\beta=1.589$, and $\gamma=1.610$; character, biaxial; sign, positive; and 2V nearly 90°. The similarity in optical properties points to a close relationship between the hydroxide and its monohydrate, which is borne out by the similarity of the X-ray patterns.

The monohydrate was also obtained by slow evaporation of a saturated solution of strontium hydroxide at the boiling point. Many of the larger crystals were in the form of hexagonal prisms, although it is evident from the optical properties that the symmetry cannot be truly hexagonal. The preparation, when dried at 110° C, lost weight equivalent to 1.23 moles of water. At 900° C it lost an additional 1.02 moles, corresponding to conversion to SrO. The loss at 110° C is evidently due to the expulsion of the 1 molecule of water of hydration, the small excess presumably resulting either from entrapped moisture or from the presence of a small amount of the octahydrate. Most of the precipitated hydroxide adhered tenaciously to the flask, and there was microscopic evidence of reaction with the glass, with the formation of minute crystals of strontium silicate hydrate ($3SrO \cdot 2SiO_2 \cdot 4H_2O$) [4]. The fact that strontium hydroxide monohydrate is formed under these conditions indicates that it is the stable phase at the boiling point.

[1] Figures in brackets indicate literature references at the end of this paper.

TABLE 1. *Interplanar spacings and relative intensities of X-ray diffraction lines for strontium hydroxide and its monohydrate*

$Sr(OH)_2$		$Sr(OH)_2 \cdot H_2O$	
d	*I*	*d*	*I*
A		*A*	
6.21	17	6.18	100
5.21	80	4.54	95
4.95	25	3.65	25
4.56	14	3.36	44
4.14	3	3.14	60
3.847	55	2.95	7
3.651	7	2.84	35
3.358	7	2.81	78
3.302	38	2.47	30
3.132	100	2.36	8
3.073	23	2.29	50
2.922	30	2.23	80
2.903	58	2.10	14
2.848	5	2.07	14
2.815	8	1.974	18
2.747	10	1.824	23
2.602	4	1.815	7
2.473	35	1.798	4
2.343	62	1.760	10
2.294	24	1.750	8
2.168	16	1.737	6
2.107	3	1.693	8
2.093	28	1.678	7
1.978	7	1.625	15
1.960	27	1.603	7
1.947	60	1.585	7
1.887	25	1.549	12
1.835	5	1.531	12
1.823	3	1.518	6
1.810	18	1.510	2
1.746	9	1.481	7
1.697	24	1.426	4
1.661	9	1.407	8
1.649	9	1.378	8
1.624	17	1.368	2
1.574	7	1.340	6
1.535	10	1.313	10
1.530	11	1.303	2
1.512	5	1.287	6
1.4942	4	1.267	4
1.4895	3	1.235	13
1.4742	4	1.227	4
1.4600	9	1.219	2
1.3764	3	1.211	2
1.3585	10		
1.3076	5		
1.2825	7		
1.2664	8		
1.2343	4		
1.2268	5		
1.2187	11		
1.2065	4		
1.1969	3		
1.1794	6		
1.1603	6		
1.1288	7		
1.1000	3		
1.0731	3		
1.0567	3		
1.0297	3		
1.0055	3		

X-ray powder diffraction patterns for the two compounds are given in table 1. These were made with an X-ray Geiger-counter diffractometer, using copper Kα radiation. It may be noted that the two patterns are quite similar, especially in the size of the larger spacings.

3. Summary

Strontium hydroxide and its monohydrate have been prepared, and their optical properties determined. The refractive indices are: for $Sr(OH)_2$, $\alpha=1.588$, $\beta=1.599$, and $\gamma=1.610$; for $Sr(OH)_2 \cdot H_2O$, $\alpha=1.570$, $\beta=1.589$, and $\gamma=1.610$. Both are biaxial, positive, with 2V near 90°. X-ray diffraction patterns are given.

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4. References

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