Diamagnetic Susceptibility of Zinc Oxide

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The reported values of specific diamagnetic susceptibility of zinc oxide are in poor agreement with each other. They include -0.29×10^{-6} and -0.43×10^{-6} by Hüttig et al.[1], -0.31×10^{-6} for the active oxide and -0.26×10^{-6} for the ignited sample by Turkevich and Selwood[2], and -0.3058×10^{-6} by Prasad et al.[3] It is well known that zinc oxide contains some kinds of lattice defect, namely cation and anion vacancies, besides an excess of zinc in interstitial positions, and their concentrations can be controlled by the type and the content of impurities. In the cases of zinc and cadmium sulfides, the diamagnetism was reported to depend on such variables. Therefore, measurements of

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[1] G. F. Hüttig, H. Radler and H. Kittel, *Z. Elektrochem.*, **38**, 442 (1932).

[2] J. Turkevich and P. W. Selwood, *J. Am. Chem. Soc.*, **63**, 1077 (1941).

[3] M. Prasad, S. S. Dharmatti and H. V. Amin, *Proc. Indian Acad. Sci.*, **26A**, 312 (1947), cf. *C. A.* **42**, 4410.

[4] S. Larach and J. Turkevich, *Phys. Rev.*, **98**, 1015 (1955).

TABLE I

DIAMAGNETIC SUSCEPTIBILITY OF ZINC OXIDE

	Addition (one mole per cent.)					
	none	Al_2O_3	Ga_2O_3	Li_2O	Ag_2O	$ZnCl_2$
Low ignition	0.327	0.325	0.330	0.329	0.332	0.331
High ignition	0.333	0.329	0.335	0.336	0.330	0.331
Red	0.326					

magnetic susceptibilities of zinc oxides containing various impurities were undertaken for the purpose of examining the effects of lattice defects.

The slightly acidic solution of zinc sulfate was treated with metallic zinc to remove heavy metal ions. Ferrous iron was oxidized with hydrogen peroxide, and removed as the coprecipitate with zinc hydroxide by the addition of a small quantity of ammonium hydroxide solution. Then zinc oxalate was precipitated from the solution purified by the above mentioned methods, and calcined at 400°C for 6 hours. In the following section, we shall call the sample thus prepared zinc oxide (1). The samples containing Al_2O_3, Ga_2O_3, Li_2O, Ag_2O, and $ZnCl_2$ were prepared by the addition of definite amounts of solutions of the corresponding nitrates or $ZnCl_2$ to zinc oxide (1), The impregnated materials were dried at 110°C, and heated at 400°C for 6 hours (low ignition series) or at 900°C for 3 hours (high ignition series). Red zinc oxide was prepared by heating a mixture of zinc oxide (1) and ammonium nitrate (1:2) to the point of deflagration, and separated from residual ammonium nitrate and white zinc oxide by elutriation. According to Ehret and Greenstone[5], the amount of the excess of zinc in red zinc oxide prepared by this method is about 0.02 per cent.

The magnetic susceptibilities were measured using a Gouy balance as described in the previous paper[6]. The values multiplied by -10^6 are summarized in Table I. The susceptibility values of all samples are in accordance with one another within the limit of experimental error. Contrary to the results given by Turkevich and Selwood, diamagnetism seems to be rather great in the high ignition series. We could see the effects of impurities on the sintering of zinc oxide by the remarkable difference between their packing densities in a Gouy tube. For example, zinc oxide (1) was about twice as bulky as red zinc oxide and about 1.5 times as bulky as the samples containing Li_2O or Ag_2O in high ignition series. However, our magnetic data presented in Table I show conclusively the sintering and the type of impurities, consequently the kind and the concentration of lattice defects, do not appreciably affect the magnitude of the susceptibility of zinc oxide, and the disagreement between literature values can not be attributed to these variables.

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[5] W. Ehret and A. Greenstone, *J. Am. Chem. Soc.*, **65**, 872 (1943).

[6] H. Akamatu and Y. Matsunaga, This Bulletin, **26**, 364 (1953).