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Preparation and Colorimetric Properties of a Magnesium-Oxide Reflectance Standard.

The smoke from magnesium freely burning in air deposited on a satisfactory base forms a uniform, fine-grained, diffusing surface of high reflectance. By observing a few simple precautions, this surface of magnesium oxide (MgO) may be made reproducible; hence, it serves as a convenient and reliable standard.

1. The magnesium should be obtained in the form of turnings of approximately 0.02 in. in thickness and 1/8 in. in width, preferably of spiral shape, and containing a minimum of magnesium dust. Suitable material may be obtained of the American Magnesium Corporation, 2210 Harvard Avenue, Cleveland, Ohio, the Aluminum Company of America, Gulf Building, Pittsburgh, Pennsylvania, Sterling Products Company, Easton, Pennsylvania, the Pfanstiehl Chemical Company, Waukegan, Illinois, and others.

2. The oxide must be deposited on a surface not affected in air by the heat from the burning magnesium. A satisfactory base may be made of (a) aluminum, (b) block porcelain, (c) sheet steel coated with white vitreous enamel, or (d) a baked surface of a sprayed mixture of magnesium oxide powder and distilled water (7, p. 21)*. Milk or opal glass is often unsatisfactory because it easily cracks from heating. Depolished surfaces are better than polished because the oxide adheres better; for the same reason, metallic surfaces are usually to be preferred to nonmetallic. Surfaces of reflectance high and uniform throughout the spectrum are better than dark or chromatic surfaces because with the former a thinner layer of oxide is trustworthy. The thinner layer is desirable apart from speed of preparation because it does not chip off so readily.

3. Place a small quantity (about 5g) of the chips on a refractory dish (zirconium silicate and magnesite are suitable refractory materials) and ignite them with a hand blow torch or bunsen burner. Work the unignited chips beneath the flame until a slowly burning ball or clinker is formed; this gives a steady stream of smoke.

4. Place the surface to be coated about 8 to 10 cms above the flame and tilted about 30 degrees from the horizontal. Use of smaller distances results in a coarse-grained deposit and risks contamination by possible impurities in the magnesium (3).

(*) Numbers in parentheses, sometimes followed by a page number, indicate references in the bibliography.

5. Move either the combustion dish or the surface being coated from side to side in order to obtain a uniform deposit.

6. When the clinker has to be turned over or broken, in order to permit the magnesium to burn completely, the surface being coated should be temporarily removed, since the burst of flame is likely to carry up large dust particles.

7. Repeat the operation several times until a sufficient deposit is obtained. The layer should be so thick that further increase produces no sensible change in reflectance; the critical thickness is about half a millimeter (4, p. 17). Do not attempt to burn a large charge of magnesium at one time. Rather, build up the required thickness by a large number of small charges. In cases where it is inconvenient to measure the thickness of the coating place a small dot of india ink on the original surface near the edge, then deposit oxide until the spot cannot be seen in good illumination. If the original surface is dark, put on one coat of MgO first; a deposit of black smoke (from a candle or smoky gas flame), in a small spot near the edge, then supplies a similar test.

8. The operation should be carried out under a well ventilated hood in order to dispose of the excess oxide.

9. The operator's eyes should be protected from the high intensities of visible and ultraviolet radiant energy by suitable goggles (4, p. 30), or other means.

10. Magnesium ribbon may be used for small surfaces instead of turnings, but for large surfaces it requires careful manipulation to produce a uniform coating because of the irregular burning of the ribbon.

The properties of a surface so prepared are as follows:

1. It is a good diffusor (1, p. 59; 2).

2. Its light reflectance, 0.97 to 0.98, is very high (1, 4, 5).

3. The reflectance varies with wave length in the visible spectrum by less than one per cent (2, 4) when the oxide is first prepared. (But see 5, below.)

4. The apparent reflectance for 45-degree incidence and normal viewing (standard conditions adopted by the International Commission on Illumination, Cambridge, 1931) is 1.00 (4, p. 29).

5. Its reflectance varies slightly with time. Although the reflectance is apparently constant with time between 550 and 750mμ, it decreases at wave lengths less than 550mμ; this may amount to as much as 3 per cent in the violet (6, p. 378), and causes the oxide to become slightly yellower with time. In such a case the changes in the trichromatic coefficients, x, y, z, and the luminous reflectance R, computed on the 1931 I.C.I. basis and for I.C.I. Illuminants A and C are as follows:

	Δ x	Δ y	Δ z	Δ R
I.C.I. Illuminant A	$+0.001_1$	$+0.000_9$	-0.001_9	-0.001_3
I.C.I. Illuminant C	$+ .001_4$	$+ .002_0$	$- .003_5$	$- .002_3$

6. It is extremely fragile. However, if the MgO is deposited in a flat trough the edges are protected from chipping off.

The first four properties listed make this reproducible surface a convenient reference standard of reflectance; its usefulness is limited by the fifth and sixth properties (lack of constancy, fragility), which make it often desirable to use working standards of reflectance carefully calibrated in terms of the freshly prepared MgO.

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