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Winter 2-2005

# A Mixture of Barium Sulfate and White Paint is a Low-Cost Substitute Reflectance Standard for Spectralon®

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Knighton, Nick and Bugbee, Bruce, "A Mixture of Barium Sulfate and White Paint is a Low-Cost Substitute Reflectance Standard for Spectralon®" (2005). *Techniques and Instruments.* Paper 11.
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# A Mixture of Barium Sulfate and White Paint is a Low-Cost Substitute Reflectance Standard for Spectralon®

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## INTRODUCTION

Barium sulfate is a white powder that has historically been used as a reference standard (Weidner and Hsia, 1981). It may be a less expensive alternative to higher priced white standards that use sintered PTFE (polytetrafluoroethylene; Spectralon®, Labsphere, Inc., North Sutton, NH). A 500 g bottle of BaSO4 costs $25, whereas reflectance standard made of Spectralon® and with a 99% reflectance factor costs $385. However, pure barium sulfate dries to a powder and easily rubs off surfaces. We sought to increase the durability of barium sulfate by mixing it with untinted white latex paint. Reflectance and durability of different ratios of this $BaSO_4$ and paint mixtures were measured from 430 to 950 nm with an Apogee-StellarNet spectroradiometer.

## MATERIAL AND METHODS

Paint and $BaSO_4$ were weighed and mixed with small amounts of water. Ratios of paint to $BaSO_4$ ranged from 10% paint to 90% paint. The mixtures were then painted on a piece of particle board spray-painted white. Five to 10 thin-coats of paint/ $BaSO_4$ were used to ensure a smooth finish. After the paint had dried, fine grit sandpaper was used to smooth the painted mixtures. The barium sulfate was chemical reagent grade from J. T. Baker Chemical Company. Porter brand silken-touch, white interior latex paint was used. Reflectance measurements were taken using the Apogee-StellarNet VIS/NIR spectrometer and Apogee reflectance probe. A Spectralon® white reference was used for comparison.

Mixtures samples were tested for durability by being rubbed with brown paper (i.e. piece of grocery bag). The amount of $BaSO_4$ that remained on the paper was then ranked relative to the other samples. Pure paint was ranked as 0, and pure $BaSO_4$ was ranked as 10.

## RESULTS

The reflectance of 100% barium sulfate mixed with water and painted on a piece of white particle board was about 1% higher than Spectralon® from about 425 nm to 600 nm but was less than Spectralon® at wavelengths greater than about 600 nm. Paint was about 7% less than $BaSO_4$ at all wavelengths (Figure 1).

Durability seems to increase linearly with the amount of paint in the mixture. However, at about 40% paint the durability decreases sharply. Durability then remains relatively constant at percentages less than 20% paint.

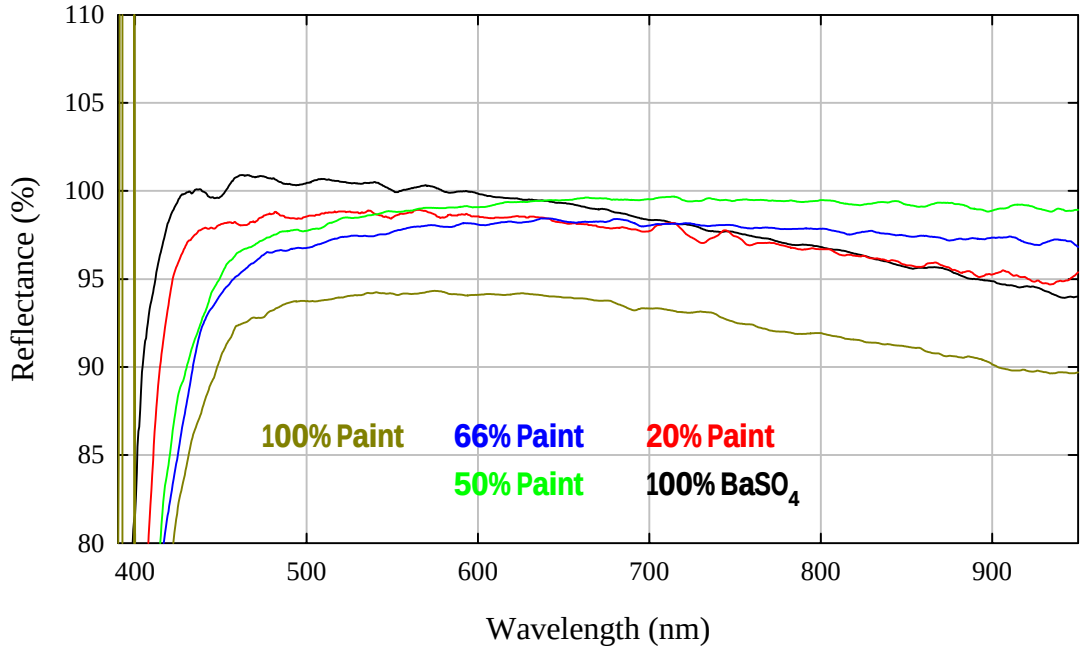


**FIGURE 1** Reflectance of pure paint and pure barium sulfate mixed with water. Spectralon® was set as 100%.

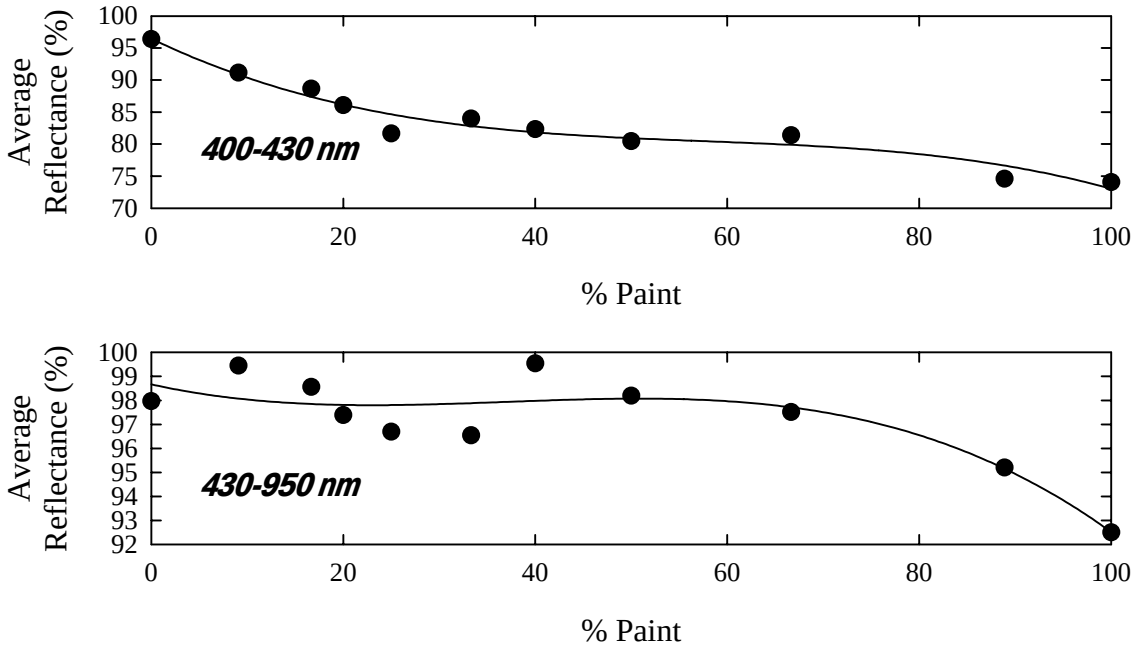


**FIGURE 2** Regression of the average reflectance percentage from 400 to 430 nm and 430 to 950 nm to the ratio of paint in a mixture as compared to Spectralon®.

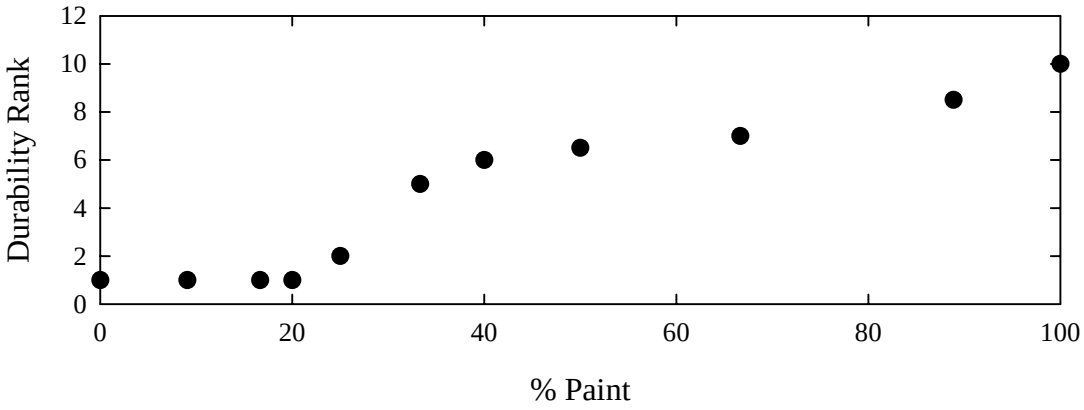


**FIGURE 3** Durability increases as the percent of paint in the mixture increases. Pure paint is ranked as 10 and pure barium sulfate is ranked as 1. Paint is more durable than $BaSO_4$.

## CONCLUSIONS

Barium sulfate is highly reflective, but can be easily rubbed off any surface it coats. Mixing $BaSO_4$ with paint greatly increases its durability. However, white paint decreases reflectance. The average reflectance from 430 to 950 nm remained relatively constant until the $BaSO_4$/paint mixture reached 50% paint. Reflectance from 400-430 nm decreased quickly with the addition of small amounts of paint (Figure 2). Durability seems to increase sharply at 20-25% paint (Figure 3).

## LITERATURE CITED

Weidner, V. R. and J. J. Hsia. 1981. Reflection properties of pressed polytetrafluoroethylene powder. Journal of the Optical Society of America. 71:856-861.