A177 *In Situ* Identification of Bismuth Vanadate in Automotive Paints Using Extended Range FT-IR Spectroscopy (4000-250cm-1) and Elemental Analysis

Edward M. Suzuki, PhD, Washington State Patrol Crime Lab, 2203 Airport Way, South, Suite 250, Seattle, WA 98134-2045*

After attending this presentation, attendees should be able to identify a yellow inorganic pigment, bismuth vanadate, *in situ* in automotive and other types of paint using infrared spectroscopy and elemental analysis. This can be useful for both identification of automotive paints and for distinguishing between paints having similar colors.

This presentation will impact the forensic science community by providing forensic paint examiners with background information about a relatively new pigment used in automotive and other types of paint.

Yellow pigments play an important role in formulating paints as they are used to help produce yellow, orange, brown, green and other colors. This is particularly true in the automotive industry, as the finishes formulated by automobile color stylists span essentially the entire range of hues and heavy pigment loads are often used to achieve the vivid colors favored by consumers. Hydrous ferric oxide, for example, is a very common yellow inorganic pigment that was identified in a large number of U.S. automobile original (OEM) finishes (1974 to 1989) from the *Reference Collection of Automotive Paints* (*J Forensic Sci* 1996;41:393-406). These included finishes with yellow, orange, red, brown, and green nonmetallic and yellow, orange, brown, olive, and green metallic hues.

In addition to hydrous ferric oxide, two other yellow inorganic pigments, Nickel Titanate (*J Forensic Sci* 2006;51:532-47) and Chrome Yellow (*J Forensic Sci* 1996;41:393-406), were also commonly used in these paints. When used as masstones (undiluted), hydrous ferric oxide and Nickel Titanate produce pastel shades (pencil yellow and lemon yellow, respectively). In contrast, Chrome Yellow, a lead chromate pigment, produces a bright hue (school bus yellow) and is more amenable for production of brilliant “glamour” shades. Use of lead-containing pigments, however, was discontinued for U.S. automobile OEM finishes in the early 1990s due to health concerns, although they continued to be used for vehicles produced in Europe (*Sci and Justice* 1999;39:181-7). Most of the replacements for Chrome Yellow were organic pigments as they usually produce brighter colors than inorganic pigments. Compared to these organic pigment replacements, Chrome Yellow was more durable, had a greater opacity, and cost considerably less. The loss of Chrome Yellow from the palette of U.S. automobile color stylists thus had a pronounced adverse effect on the formulation of some automobile paint hues.

In 1985 a new yellow inorganic pigment, Bismuth Vanadate ($BiVO_4.nBi_2MoO_6$ n = 0 to 2), was introduced commercially. Like Chrome Yellow, Bismuth Vanadate produces a very bright hue and is quite durable. Its other attributes include high tinctorial strength, high gloss, good gloss retention, good hiding power, excellent solvent- and heat-resistance properties, and low toxicity. Consequently, Bismuth Vanadate has become an important automotive paint pigment in recent years. It has, to some extent, filled the large void that was created when use of Chrome Yellow was discontinued.

This presentation describes the identification of Bismuth Vanadate *in situ* in automotive paints using Fourier transform infrared (FT-IR) spectroscopy (4000 to 250 cm^{-1}) and X-ray fluorescence (XRF) spectrometry. The various formulations of Bismuth Vanadate produced by BASF and Ciba, the main suppliers of this pigment for the North American automotive OEM and refinish markets, differ somewhat. In a few cases, they can be distinguished in automotive paints using infrared spectroscopy, elemental analysis, or both, particularly based on the presence or absence of molybdenum and certain far-infrared absorptions. Bismuth Vanadate is rarely used as a masstone and most automotive finishes in which this pigment was identified also contain Isoindoline Yellow, a common organic pigment used for automobiles (*J Forensic Sci* 1999;44:1151-75), hydrous ferric oxide, rutile, or combinations thereof. **Paint, FT-IR, XRF**