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X-Ray Microanalysis of Art Glass Surfaces

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The world of art glass and art glass jewelry has expanded greatly in recent years. Many new glass formulations have brought a host of new colors into the marketplace from both large and small scale producers. The availability of low cost/high quality torches and other tools has brought art glass to the hobbyist. Many of the colorants in glass are metallic compounds (oxides, chlorides, etc.). One technique commonly used in art glass is creation of a metallic 'reduction' surface. These can be very colorful, attractive surfaces and are popular in art glass jewelry. As a rule these effects are produced when a glass with a high metal content is exposed to a flame with a high fuel to oxygen ratio (aka reduction flame). This flame chemistry tends to remove oxygen from metal oxides and leaves pure metal on the surface of the glass. The color of this surface is often assumed to indicate the metal in question and, combined with the naming of stock glass colors, end users may reach erroneous conclusions about the actual chemical nature of the surface. Gold appearing surfaces are often assumed to be metallic gold, silver surfaces silver, etc. Analysis of these surfaces shows that visual color and color name may, in some instances, be misleading.

Three samples of glass from two different manufacturers were purchased on the commercial market. Effetre 456 Rubino Oro and Effetre 276 Dark Silver Plum (Effetre Glass, Murano, Italy) and Kugler 215 Tobacco Brown (Friedrich Farbglashütte GmbH, Kaufbeuren-Neugablonz, Germany) were used in this study. Three separate samples of Effetre 456, two of Effetre 276 and one of Kugler 215 were tested. The samples were examined in a LEO 1450vp scanning electron microscope operating at kV20 in secondary and backscatter imaging modes. The samples were further analyzed by Energy Dispersive X-ray Microanalysis (EDS) using a Rontec X-Flash X-ray microanalysis system. High magnification images of the reduced Effetre 456 showed the surface covered with bright round islands < 0.5μm in diameter. X-ray microanalysis yielded a spectrum consistent with that of Si and Pb for the overall surface. The small spots were consistent with areas of high lead content (Fig 1 A, B). The surface of Effetre 276 had a more textured appearance and the X-ray spectra were consistent with Si, Mn and Zn (Fig 1 C, D). The Kugler 215 glass had a similar appearance to the Effetre 456 in the SEM. The X-ray spectra were consistent with Si, Pb and Ag on the surface (Fig 1 E, F). The visual appearance of these glasses would suggest to the layman that the surface might, indeed, be either silver or gold. While both of these elements are heavy metals, they are considered safe for skin contact and are prized as materials for jewelry making. Lead, on the other hand, is not considered safe for human contact. It has been banned from use in jewelry production and is currently the subject of restrictive legislation by the Consumer Products Safety Commission [1].

Glass workers may be exposed to varying levels of toxic metal from contact and exposure to vapors arising from inadequate torch plume exhaust. Sale of items made with some of these materials on exposed surfaces may also place the maker in violation of consumer protection statutes. Artists working with or marketing these materials should familiarize themselves with the possible chemical hazards involved and take appropriate steps to ensure safe working conditions as well as avoid possible legal issues.

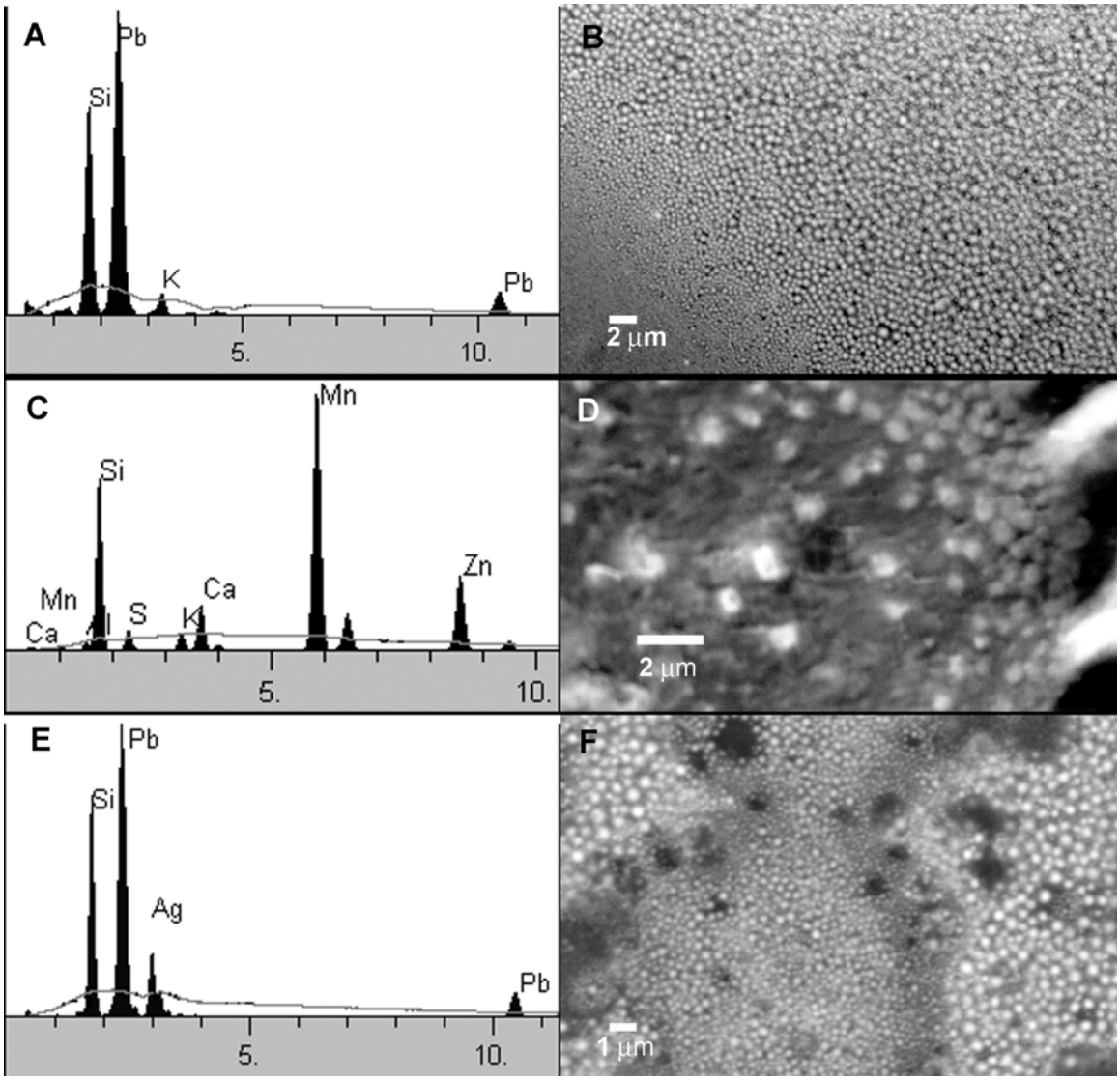

Figure 1. (**A**) X-ray spectra indicating the presence of Pb on the surface of the Effetre 265 glass. (**B**) SEM image showing the small, bright areas of probable high PB content. (**C**) X-ray spectra indicating the presence of MN and ZN on the surface of the Effetre 456 glass. (**D**)SEM image shows larger, less evenly distributed concentrations of metal. (**E**) X-ray spectra showing the presence of PB and Ag on the surface of the Kuglar 215 glass. (**F**)Distribution of the metal concentrations is similar to that of Effetre 256.

References

1. Consumer Product Safety Improvement Act of 2008, http://www.cpsc.gov/cpsia.Pdf

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