Understanding nineteenth century glass deterioration through artificial accelerated aging

Elizabeth Montagnino*†[1], Isabelle Muller[1], Andrew Buechele[1], Stephanie Zaleski[2], and Nikolaus Deems[1]

[1]Vitreous State Laboratory, The Catholic University of America – 620 Michigan Ave Washington, DC 20064, United States

[2]The Library of Congress – Washington, DC 20540, United States

Abstract

The Parisian clock-maker, Claude Laurent, fabricated glass flutes in the early nineteenth century. With 189 flutes known worldwide, 20 of them are housed in the Dayton C. Miller Collection at the Library of Congress. Some of the flutes show significant deterioration noted by a fogginess referred to as "crizzling," which raised questions concerning the stability of the glass. The flutes were originally believed to be made from a stable lead-based glass "flûte en cristal" but most were later analyzed to be potash glass.
In order to investigate the relationship between the glass compositions and observed state of deterioration, a series of five model glasses were fabricated, based on the results from elemental analyses. The model glass samples were increased incrementally in K2O content from 16.5 wt% to 20.5 wt% with SiO2 progressively lowered and fixed 2.4 wt% CaO.

Each model glass was artificially aged by three separate methods to simulate the deterioration observed on the Laurent glass flutes: i) steady state environmental aging at 90∘C and 90% relative humidity (RH), ii) aging at 90∘C and cycling RH and iii) modified vapor hydration testing at 200∘C and 75% RH. Various stages of deterioration were seen as the glass reached certain points of aging, as documented by light microscopy and cross sectional SEM-EDS analysis. The vapor hydration testing was found to be too aggressive for modeling the glass flute deterioration whereas the environmentally aged model glasses closely mimicked the observed progression of glass deterioration seen on the potash glass flutes.
Another high-potassium composition (19 wt% K2O) found in nineteenth century photographic plate glass was similarly fabricated and leach tests are ongoing to identify the role of the 9 wt% CaO in this formulation. Optimizing the accelerated aging methods will help to understand mechanisms/kinetics of glass deterioration of historical objects.

Keywords: Heritage, Glass stability

*Speaker

†Corresponding author: 36montagnino@cua.edu