**Introduction**

Using corrosion inhibitors in polyethylene glycol (PEG) solutions for the treatment of non-separable metal/wood composite artifacts recovered from the marine environment has been well studied (Cook et al., 1985; Gilberg et al., 1989; Selwyn et al., 1993). Of these inhibitors, Hostacor IT® is the most well documented for the treatment of such composite objects (Argyropoulos et al., 1999; Guilminot, 2000; Memet and Tran, 2005). Unfortunately it is no longer being produced. Studies have been ongoing at The Mariners’ Museum and Park (TMM) in Newport News, Virginia, USA on the use of sodium nitrite (NaNO₂) as a replacement corrosion inhibitor for Hostacor IT®. NaNO₂ presents several advantages including a near neutral pH, is effective at a low concentration, applicable to several metals, and has a theoretical compatibility with organic materials. It was demonstrated that NaNO₂ can be used as an option in storage solutions for marine iron alloys and, after desalinization, to prevent flash corrosion during rinsing baths (Sangouard et al. 2015; Hoffman, unpublished). Recent results also showed that 1000 parts-per-million (ppm) NaNO₂ prevents iron corrosion in 209v/v PEG 400 solutions absent of chlorides (Sullivan et al. 2016). Despite these promising results, before fully supporting the use of NaNO₂ for the treatment of non-separable iron/wood composite objects, further research was required to identify that NaNO₂ has no negative impact on the wood structure and its long-term stability after treatment.

**Method**

Waterlogged red oak samples were cut into 2.5 cm squares and placed in solutions of 20% v/v PEG 400, 40% w/v PEG 2000 and a mixture of 10% v/v PEG 400 and 30% w/v PEG 4000 with and without the addition of 1000ppm NaNO₂. Four samples were placed in each solution. Following impregnation, the wood samples were freeze-dried using a VirTis 24 x 48 general purpose freeze-dryer. The chamber was set to -22°C and the condenser -52°C with a vacuum of 15 mtorr. Samples were then evaluated visually and with colorimetry to determine if treatment solution impacted final appearance. Colorimetry measurements were taken using a C-241 Minolta colorimeter after treatment. Environmental scanning electron microscope (SEM) images of the samples were taken with a Phenom ProX Desktop SEM to assess any possible change in the cellular structure of the wood. Samples of the solutions were also freeze-dried to reduce water content and then analyzed with FTIR. This will show if NaNO₂ impacts the molecular structure of PEG or causes organic compounds to be extracted from the wood. A Thermo-Nicolet Nexus 670 FTIR was employed for analyses of the solutions before and after treatment.

**Results**

Visually, the only samples noticeably different are those that were treated with PEG 400 without the addition of NaNO₂. They appear slightly lighter than the others. The remaining samples, even those that received no treatment have barely any detectable difference in color (Fig. 1).

Colorimetry measurements confirmed these observations and show that the change in color between treated samples and untreated samples is only noticeable at a glance (ΔE*ab max. is 7.20, Table 1–2, Fig.2). These measurements also confirm that, whether NaNO₂ was used or not, change in color is not perceptible by the human eyes amongst treated samples (ΔE*ab varies from 4.3 to 4.9, i.e. less than 1.0 ΔE*ab unit). Samples treated with PEG 400 without NaNO₂ vary visually, at a glance (3.6 ΔE*ab units compared to the rest of the untreated samples), confirming visual observations of these samples being lighter.

SEM images show no NaNO₂ residue on the wood cells. There is no observable difference in the cellular structure of samples treated with and without the addition of NaNO₂ (Fig. 3)

The FTIR spectrum demonstrate the addition of NaNO₂ is not changing the structure of the PEG in solution and is not extracting anything detectable by FTIR from the wood (Fig. 4).

**Discussion and Conclusion**

In light of these results NaNO₂ does not seem to impact wood negatively or otherwise. While long term testing should be undertaken, it seems that NaNO₂ is a viable option as a corrosion inhibitor for conservators treating waterlogged artifacts composed of wood and iron in PEG solutions. It is important to note that it is best to desalinate an object before using NaNO₂ as chlorides will compete at the surface of the metal with the corrosion inhibitor impacting its efficiency. Sodium nitrite is currently being used at TMM as a corrosion inhibitor for the treatment of non-separable composite artifacts composed of waterlogged wood and wrought iron. Testing is also ongoing for the use of NaNO₂ with copper alloys in PEG.