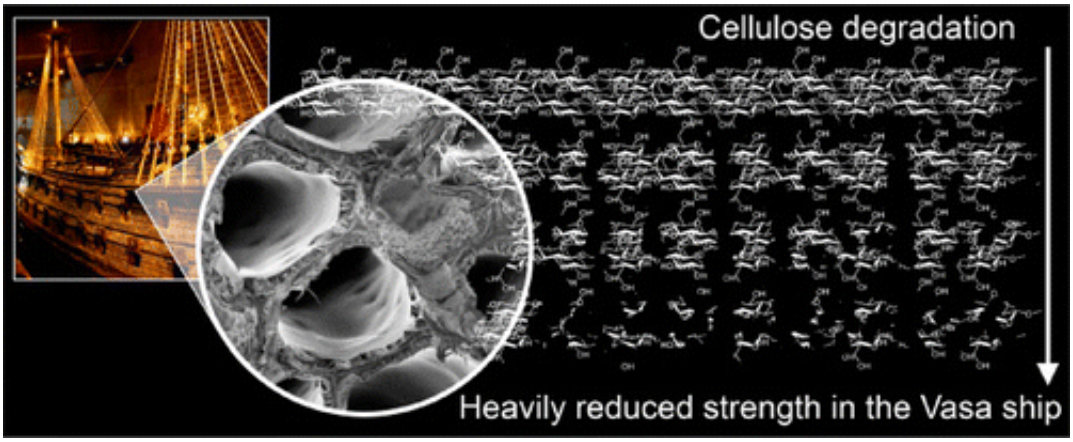
Warning on deterioration of famous Swedish warship, Vasa

August 29 2012



The famous warship, *Vasa*, displayed in a museum that gets 1.2 million visitors every year and ranks as one of Sweden's most popular tourist attractions, is deteriorating despite ongoing preservation efforts, scientists are reporting. Their study, citing a "significant" loss of strength in the ship's wood, appears in ACS' journal *Biomacromolecules*.

Ingela Bjurhager, Lars A. Berglund and colleagues explain that the *Vasa* sunk in the Stockholm harbor in 1628 on its maiden voyage after sailing less than a nautical mile. The ship was rediscovered in 1958, raised in 1961, treated with preservatives and finally put on display in the *Vasa* museum in 1990. The museum preserved the ship with polyethylene

glycol (PEG) in a thick, wax-like preparation dissolved in water and sprayed onto the wood for 17 years. Concerns about deterioration arose, and the authors set out to determine the effects of PEG, iron from nails and rivets, and sulfur from decaying bacteria on the wood's strength.

The team analyzed the strength of wood taken from various locations in the ship's hull, which is largely made of oak. They report that at its worst, the wood had weakened as much as 80 percent. They suggest the loss of strength may be a result of letting the ship dry out after its recovery, allowing oxygen to react with the iron in the wood. Although they don't foresee an immediate danger to the ship, a clear understanding of the cause of the wood's degradation will be critical to preserving it for future generations. In parallel, an improved support structure is needed to minimize the stresses and deformations in the wooden hull.

More information: "State of Degradation in Archeological Oak from the 17th Century Vasa Ship: Substantial Strength Loss Correlates with Reduction in (Holo)Cellulose Molecular Weight", *Biomacromolecules*, 2012, 13 (8), pp 2521–2527. DOI: 10.1021/bm3007456

Abstract
In 1628, the Swedish warship Vasa capsized on her maiden voyage and sank in the Stockholm harbor. The ship was recovered in 1961 and, after polyethylene glycol (PEG) impregnation, it was displayed in the Vasa museum. Chemical investigations of the Vasa were undertaken in 2000, and extensive holocellulose degradation was reported at numerous locations in the hull. We have now studied the longitudinal tensile strength of Vasa oak as a function of distance from the surface. The PEG-content, wood density, and cellulose microfibril angle were determined. The molar mass distribution of holocellulose was determined as well as the acid and iron content. A good correlation was found between the tensile strength of the Vasa oak and the average molecular weight of the holocellulose, where the load-bearing cellulose

microfibril is the critical constituent. The mean tensile strength is reduced by approximately 40%, and the most affected areas show a reduction of up to 80%. A methodology is developed where variations in density, cellulose microfibril angle, and PEG content are taken into account, so that cell wall effects can be evaluated in wood samples with different rate of impregnation and morphologies.

Provided by American Chemical Society