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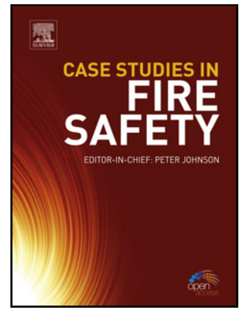

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Early stages of surface alteration of soda-rich-silicate glasses in the museum environment

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Abstract

This paper studied the alteration of three soda-rich-silicate glass types (*Cristallo*, *façon-de-Venise* and soda-lime silicate). Replica samples were exposed to different environments simulating museum-like conditions – room temperature and different relative humidities (RH). Results were analysed by SIMS, μ-FTIR, Optical Microscopy and Optical 3D profilometry. *Cristallo* appears as the most vulnerable, whilst the soda-lime glass appears as the most resistant to the environmental deterioration. The thickness of the altered layer is proportional to the time of exposure and to the RH of the surrounding atmosphere. From the results obtained, the glass composition and the water available and adsorbed to the surface strongly influence the kinetics of the surface alteration.

Keywords: soda-rich-silicate glass, SIMS, μ-FTIR, deterioration, cultural heritage
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1. Introduction

Damage to cultural property within the museum occurs mainly due to environmental conditions (*e.g.* humidity, among other factors) which have long been the concern of conservators [1]. Although it is correctly seen as chemically stable, glass artefacts exposed to the environment undergo surface transformations and deterioration [2, 3]. Glass alteration by atmospheric water is a well known problem, and it expressly takes place in the museum environment. Depending on its chemical composition and on the environmental weathering conditions, the time required for this slow process to produce damage can range from hours to years. Therefore, different alteration behaviours have been reported [2, 4, 5].

The use of combined surface analysis methods to thoroughly characterise the glass durability and corrosion through a systematic approach to a series of compositions and environments has long been demonstrated [6] and has until now proved its importance [7, 8]. Surface characterization techniques are applied in this case to investigate the thin corroded layers formed as consequence of glass weathering processes [9].

Several studies have been published concerning corrosion models and mechanisms on soda- and soda-lime-silicate glasses (recent publications are, for instance [10, 11]). Many of the studies of this type of glass and corrosion are, nevertheless, directed at the commercial glasses and industrial production improvements (*e.g.* [12]) and to waste glass, whose properties and corrosion behaviour are strongly dependent on the environment at which they are exposed to (aqueous, acidic and alkaline solutions, with the contribution of several other corrosive materials, such as toxic waste) (*e.g.* [13–15]).

Studies on aqueous solutions (*e.g.* [12]) and accelerated ageing at high temperatures (*e.g.* [1, 4]) have also been carried out in the past. Important corrosion models have arisen from these works (*e.g.* [16]). It is a fact that some may apply or are related with historical glassworks, namely for objects in waterlogged or ground-water environment [17–23], window glass [9, 13, 24, 25], or museums environment accelerated tests [11]. Nevertheless, only a few recent studies concern the problems directly related to museum glass objects and their real environment (and can be found mainly in [7, 26–32]).

Museum objects have varying compositions and origins and the wide variety of alteration behaviours still lacks understanding, as part of the implementation of a preventive conservation strategy.

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