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Original article

Luminescent glasses in art

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Abstract

In this study the application of luminescent glasses under UV light in artworks is explored. Several lanthanide oxides were used in the glass composition to obtain different colours. A brief comparison with the conventional glass artwork using neon is made. Future conservation was taken into account and the compatibility studies of mixtures of different glasses were studied.

Keywords: Light effects; Luminescent glass; Art glass; Rare earth oxides; Conservation

1. Research aims

The objective of this work was the study of the effects of light in artworks using luminescent glasses under ultraviolet radiation. The use of different glass types and colours are explored having in mind the conservation of artworks made and their future use in cultural heritage buildings.

2. Introduction

The use of materials with special optical properties has been explored by many artists in contemporary glass art for more than 30 years. Light has a unique effect in the art field, and several artists made neon installations in museums, cloisters and other public places. Valerig Bugrov made a 35 m long neon installation, ‘‘Falling Sky’’, in the ceiling of the Grand Palais in Paris, the same place where George Claude showed a neon installation in 1910. In another work of the same author, ‘‘Light field’’, 240 m of neon stretches between two historical war buildings, the Brandenburg Gate and the Siegessaeule Column of Victory in 1989 [1]. Mischa Kuball made the ‘‘Refraction House’’ in 1994 at Stommeln Synagogue near Cologne. The light was placed behind the windows inside the Synagogue [2]. Artists as Bruce Nauman, Dan Flavin and James Turrel chose light as an art medium, thus their works became very important steps in contemporary art [3]. Bruce Nauman in ‘‘Window or Wall Sign’’, made in neon tubes in 1967, wanted to create a luminescent and dynamic writing. In his works, Dan Flavin manipulates internal and external spaces or modifies the architecture of the space, changing the perception of the light [4]. James Turrel, in ‘‘Wedgework III’’, 1980, seeking a different perception of light and space, works the light in such a way that there is a diffuse dialogue between the material and immaterial that become a whole [5]. Pedro Cabrita Reis is an artist who does

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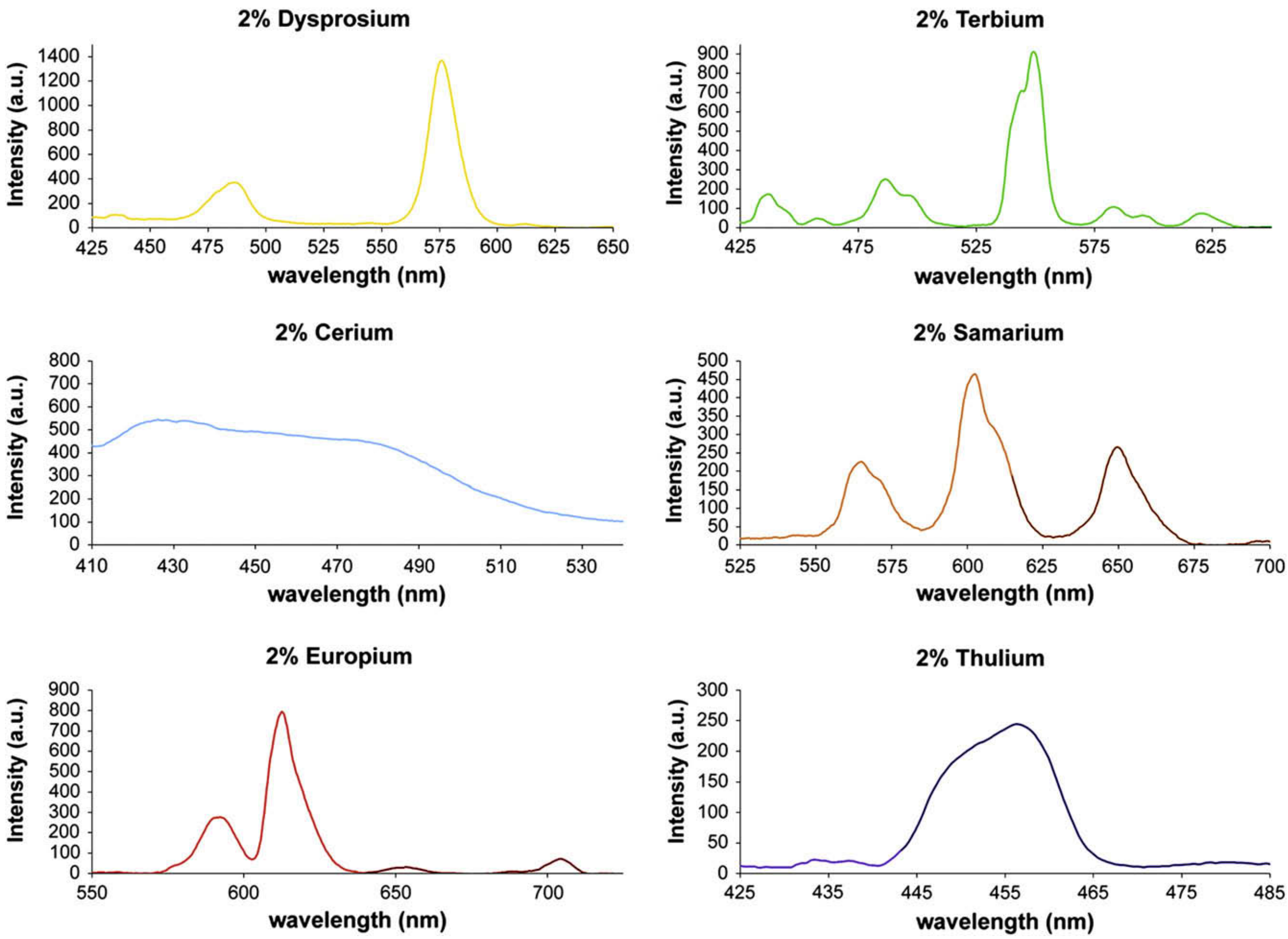

Fig. 1. Emission spectra of soda-lime silicate glasses with 2% (wt%) of different rare earth oxides.

conceptual works, constructive models and installations using fluorescent light tubes. An example of his work is “Cathedral #2”, 1999 [6]. José de Guimarães exhibited a neon installation in the cloister of the Alberto Sampaio Museum, in Guimarães. In several of these examples, fluorescent materials were used in some installations.

Another light effect can be seen in uranium glass objects. Uranium glass has been used since 1830s in decorative arts [7]. Intense day light imparts to the uranium glass a special bright colour due to the luminescence effect under UV light of the solar spectrum. In some museums this effect is explored using collections in dark glass cases with a UV light.

Although luminescent properties of the lanthanide oxides have been investigated for a long time [8], luminescent glasses which emit light with different colours under ultraviolet light are now starting to be employed in art objects. The light effects obtained improve the aesthetic value of the artworks and their application in glass sculptures seems to have unusual possibilities. The other application of these new materials would be in cultural heritage buildings trying to use them in stained glass windows where the colour would be seen during the night.

The emission of light with different colours under ultraviolet radiation of wavelength ca. 380 nm is achieved adding to the raw materials for making the glass, europium, cerium, terbium, dysprosium, thulium and samarium oxides [9]. The syntheses are easy and are being developed by the authors.

3. Experimental

The glasses made were mainly soda-lime silicate glasses with 2% of rare earth oxides (europium, terbium, cerium, samarium, thulium or dysprosium). The raw materials were heated at 1500 °C for 24 h under atmospheric conditions in

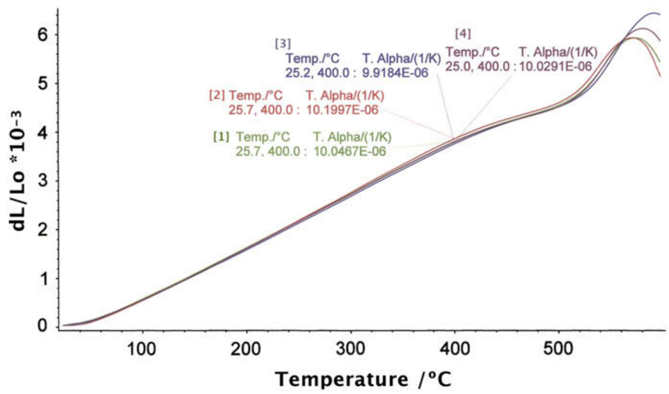

Fig. 2. Thermal expansion curves: 1 – terbium glass, 2 – europium glass, 3 – dysprosium glass, 4 – cerium glass.

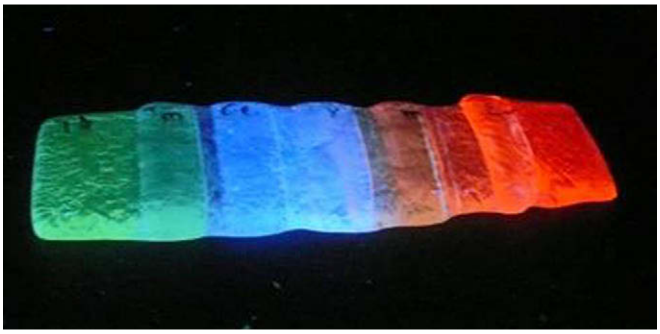

Fig. 3. Fusion of the soda-lime silicate glasses with the several rare earth oxides. From left to right: terbium, thulium, cerium, dysprosium, samarium and europium.

ceramic crucibles. The melted glasses were poured into a metal sheet and then were carefully annealed at about 540 °C for 1 h and cooled slowly to room temperature.

The emission spectra of the glasses synthesized were performed under UV light of 380 nm wavelength. They were measured with an Avantes AvaSpec-2048 fibre optic spectrometer (Avantes, Eerbeek, Netherlands). It is a fibre optic spectrometer with a 300 lines/mm grating. The operational range is 200–1100 nm, and the instrument has a FWHM resolution of 2.4 nm. The emitted light was measured using a 200 μm reflection probe (Avantes FCR 7-UV-200). It consists of six illuminating fibres surrounding one central reading fibre; the diameter of each of these fibres is 200 microns.

Compatibility tests were made with a dilatometer Netvcsh – Dil402PC. The thermal expansion curves were made in the temperature range 25–400 °C with cylindrical samples with 6.5 mm of diameter and 30 mm of length. Compatibility tests were also made fusing the glasses with the different lanthanide oxides and using optical stress spectroscopy.

Small samples (ca. 500 g) were prepared in the VICARTE laboratories and after studying their properties 50 kg batches were made in the Glass Centre CRISFORM, in Marinha Grande.

Sculptures were made using several techniques: kiln casting, pâte de verre, slumping and fusing. In the kiln casting technique silica/plaster moulds where the glass is placed inside were used [10]. Glass billets and granular glass for kiln casting and grains, frits and powder for pâte de verre were used. Several firing schedules were tested [11,12] in order to achieve the best results to avoid stress or fractures.

After firing all the objects, they were observed in a polariscope Sharple Senarcon Strhin to check for stresses inside the piece. Finally the glass was polished by eroding the surface with abrasives and further treatment with a mixture of hydrofluoric and sulphuric acids [13].

4. Results and discussion

The emission spectra obtained under UV light, showed in Fig. 1, were characteristic of the different rare earth oxides used [14]. Compatibility tests of the different glasses produced

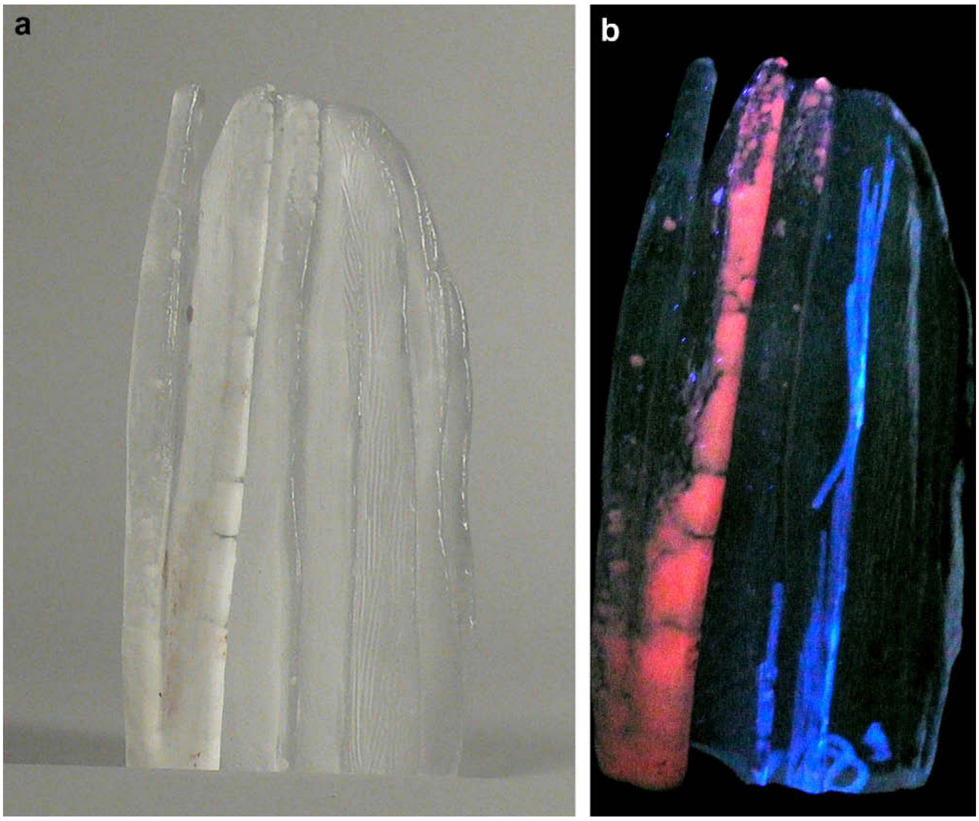

Fig. 4. Casting piece, using transparent glass, cerium glass and europium powder. In the left the piece is in day light, on the right is under UV light.

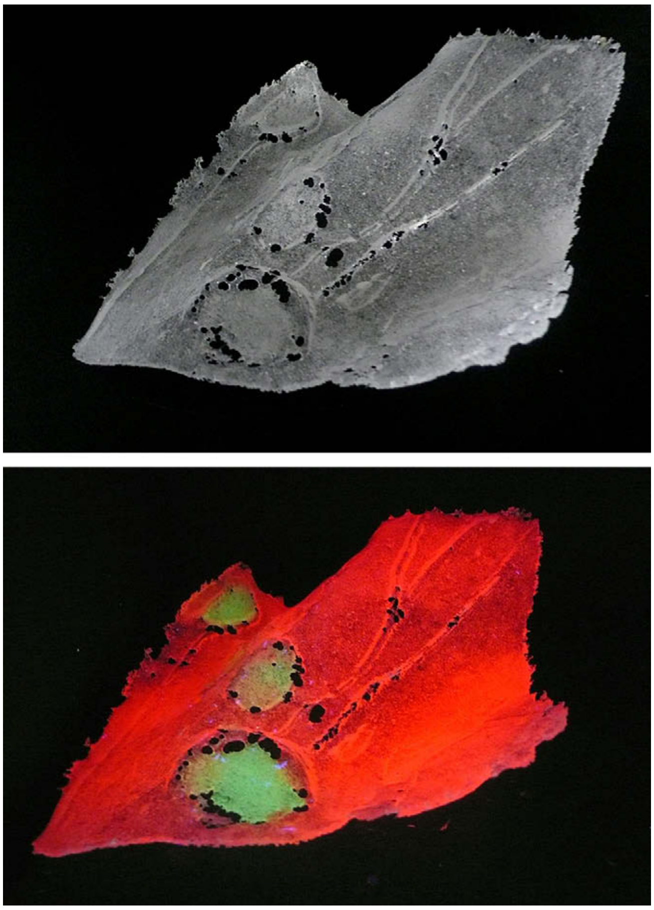

Fig. 5. Pâte de verre piece, using europium frit and powder and terbium frit.

were made using a dilatometer in a temperature range of 25–400 °C. The results obtained for the glasses with terbium, europium, dysprosium and cerium are shown in Fig. 2. Usually two glasses are considered compatible when the difference between their thermal expansion coefficients is less than $0.5 \times 10^{-6}\ K^{-1}$ [15]. The thermal expansion coefficients obtained, were $10.05 \times 10^{-6}\ K^{-1}$, $10.20 \times 10^{-6}\ K^{-1}$, $9.92 \times 10^{-6}\ K^{-1}$ and $10.03 \times 10^{-6}\ K^{-1}$ so the differences are less than $0.5 \times 10^{-6}\ K^{-1}$. These results showed that all the glasses with lanthanides were compatible with each other, and also compatible with the glass without the addition of the rare earth oxide, this one having a thermal expansion coefficient of $10.41 \times 10^{-6}\ K^{-1}$. Tests were made fusing several glasses together to check their compatibility. An example is shown in Fig. 3.

The firing schedules tested allowed the determination of the highest temperature to be used for the different annealing techniques. For instance, regarding the casting technique, it was observed that the best results were achieved at 830–850 °C for 2 h. A test made at 890 °C showed devitrification on the surface. Concerning the pâte de verre technique, the schedules where determined for hollow pieces. For full fusing the best temperature found was 780–800 °C, and for tack fusing, the technique consisting in heating until the glass just sticks together with each piece retaining its individual character, the best temperature range was 700–740 °C.

Fig. 6. Sculptures with luminescent glass.

For the future durability of the artworks several annealing tests were made. For the glasses used in artworks the best annealing temperature range is 500–530 °C being the strain point 470 °C.

To prove that the glass was well annealed each object was checked in a polariscope. Among the glass pieces casted some of them did not indicate any stress, while in others the residual stress observed was acceptable.

Some examples of the glasses studied are given in Figs. 4 and 5 showing that all the materials remain transparent. In one of them the use of grinding glass with europium oxide suggests the use of enamels in future luminescent stained glass.

5. Final remarks

The luminescent glasses studied show that they can be used either in sculpture as showed in Fig. 6 or in glass panels; future work is in progress. The light effects involving several colours are exceptional. In glass panels the annealing would be much easier due to the smaller thickness involved. The compatibility tests proved that the glasses with different lanthanides can be mixed. Further work having in mind the integration of these materials in culture heritage buildings is under study.

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