Light-Emitting Prints on Glass

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ABSTRACT

This research project aims to extend the scope of fine art printing on glass using innovative photoluminescent enamels. This paper demonstrates how these newly created materials, developed by a multidisciplinary team of artists and chemists, can be used as ink to print on glass, both with direct methods and through transfer papers (decals). The methodology used involved studio-based experiments and sampling tests, aiming to verify the ease of adopting identical printing approaches to screen printing, intaglio and photopolymer techniques on paper and glass, and evaluating whether the extent of techniques and respective marks produced were compatible with the application of luminescent enamels. Photoluminescent glass inks have a very attractive aesthetic effect for their ability to change colour and re-emit light after exposure to ultraviolet radiation. This represents a unique opportunity for artists wishing to work on the fields of light, colour, perception and visuality. The unique features of light-emitting images are discussed from a conceptual and aesthetic realm in two installation projects which seek to shape visual experience, combining the visual with the haptic.

INTRODUCTION

This paper addresses a research project at the Faculty of Fine Arts in the University of Porto (FBAUP) and i2ads research unit, in partnership with the research unit VICARTE – glass and ceramics for the arts FCT/NOVA, where, in the last few years, technological research has focused on the possible combination between glass and print media.

Since 2004, a multidisciplinary team of artists and scientists has been researching and developing luminescent glasses at the research unit VICARTE – glass and ceramics for the arts, at the campus of the Faculty of Science and Technology, NOVA University of Lisbon. Several financed projects, such as Glass in Art: Light and Colour (2004) and Glass Art and 2D and 3D printing (2007), allowed the development of different types of luminescent glass by incorporating rare earth oxides in the vitreous matrix, enabling a wide palette of colours to be produced in soda-lime silicate, borosilicate and lead glass (Almeida et al., 2008). Different types of luminescent glass are perceived as mostly colourless in natural light, but in the presence of ultraviolet light, they take on the luminescence of the rare earth oxide incorporated in the glass (Laia and Ruivo, 2019). Several luminescent colours can be produced by using different rare earth oxides:

Figure 1

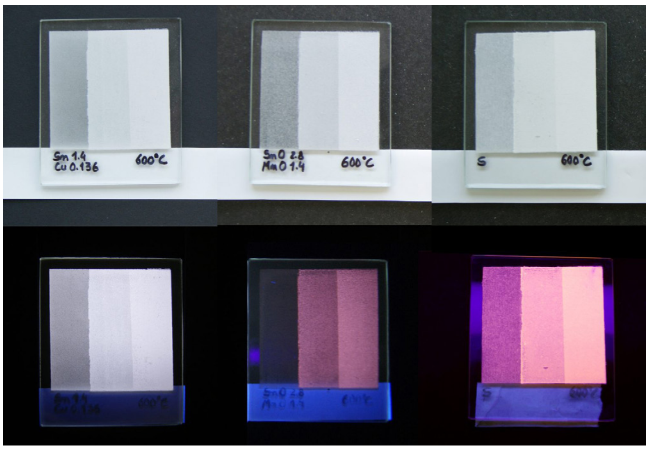

Figure 2

Figure 1. From left to right: equipment used to sodalite's synthesis: horizontal tubular electric furnace (TH1300, Termolab); aspect of sodalite, after synthesis, under visible light; aspect of sodalite powder, under visible light
Figure 2. Direct screen printed films depositions. From left to right: copper oxide doped glass enamel; manganese oxide doped glass enamel; sulphur zeolite composite. First row, samples viewed with visible light and bottom row, samples viewed with UV light

europium – red; samarium – orange; dysprosium – yellow; terbium – green; cerium – blue and thulium – violet (Ruivo et al., 2014). VICARTE and several renowned artists have exploited the potential of these rare earth modified types of glass and enamel in sculptures and paintings, creatively using luminescence in artworks and presenting them in national and international exhibitions.

Meanwhile, two multidisciplinary projects were initiated at the Faculty of Fine Arts in Porto University (FBAUP) and i2ads research unit: Glass and Print: the creation of alternative substrates and matrices for printmaking (2012) and Glass and Print: single firing on glass surfaces (2015). These projects focused on the collaboration between FBAUP's areas of printmaking, glass and ceramics technology. They sought to broaden the range of techniques available and to support artistic projects. For example, several hypotheses of how to print on glass were tested using decals on two and three-dimensional glass surfaces. Firstly, the transfer printing process was addressed, inspired by a range of solutions used and reported in the 19th-century industrial context of decorative ceramics. This knowledge and the very same solutions have been adopted and adapted for use in an artistic context. Experimental methods of paper preparation and ink production were tested, with a clear focus on the handcrafted printed decals, optimized for fine art imagery. Several historical fine art print techniques were tested by using photopolymer plates, including autographic imagery and methods of transferring digital photographic imagery.

What is intended in this paper is to summarize the proceedings of printing on glass through direct printing methods and transfer paper process with the innovative photoluminescent enamels developed in VICARTE, representing a unique opportunity to address issues such as light, colour, perception and visuality. The drive for this kind of research is to provide studio-based accessible handcrafted solutions, which is expected to be useful for artists and designers using glass and printmaking media.

RECOVERING GLASS: FROM HISTORICAL PRINTING SUBSTRATE TO CONTEMPORARY PRINTMAKING MEDIA

The crossover between Glassmaking and Printmaking can be traced back to 18th century England (Petrie, 2006). Around 1750, in the context of the ceramic decoration industry, images engraved on copper plates were transferred to glazed ceramic surfaces using bat printing. This involved a gelatine slab which was pressed onto the oiled intaglio plate then onto the glassy surface, and finally dusted with metal oxides powder (Turner, 1907; Scott, 2002; Petrie, 2011). Soon after, the potter's tissue method was used for transferring engraved or etched images, from metal plates, having been inked with enamel pigments, and transferred to underglaze ware. The gelatine bat was replaced by a smooth fine paper coated with a solution of soft soap and water (Copeland, 2000). The tissue was applied face down onto the surface of the ware and the back of the paper rubbed to transfer the image, which would be fired in the kiln to completely bond the enamel ink to the

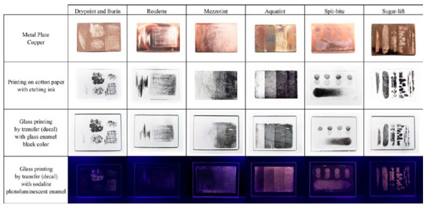

Figure 3

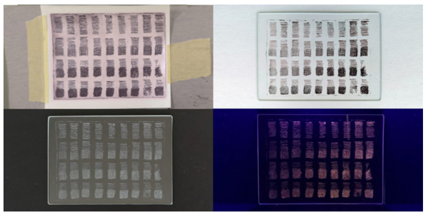

Figure 4

Figure 3. Intaglio samples. Views from the copper metal plates, printing on cotton paper, transfer printing on glass with black enamel and transfer print on glass with sodalite photoluminescent enamel
Figure 4. Line etching samples with different periods of time immersed in the acid. The nine columns correspond to the following exposure times: 6, 12, 18, 24, 30, 36, 42, 48, 54 minutes. At 54 minutes, the depth is about 0.5 mm. From left to right and top to bottom: printed decal with commercial black enamel; transfer print on glass; transfer print with sodalite on glass (visible light); transfer print with sodalite on glass (UV light).

surface of the ceramic.

Subsequent developments of this last process, combined with the invention of lithography by Aloys Senefelder in 1796, made it possible for the use of transfer paper, also known as decalcomania or simply decals, for mass production of printed glass slides for magic lanterns (Frutos, 2013). The magic lantern was a popular optical toy that projected images, and held a particular status in the 19th-century cultural imagination (Armstrong, 2008). In fact, glass's engagement with light and optics was commonly involved in the production of negatives in the early photographic processes, like wet plate collodion and ambrotype (Crawford, 1979). The glass plate was coated with a solution of silver nitrate in a binder such as collodion or albumen, which was then exposed to light and fixed, resulting in an imprint of an evanescent moment.

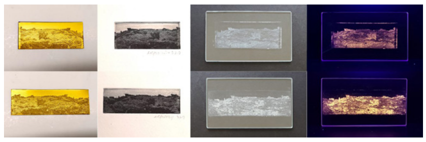

Figure 5

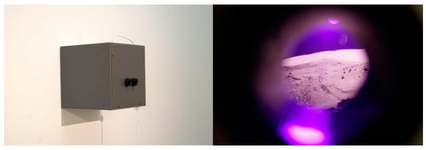

Figure 6

In recent years, there has been considerable interest in the creative potential of printing onto glass (Petrie, 2006). Alexander Beleschenko and Brian Clarke have both consistently pushed the boundaries of stained glass as a medium, since the 80s, in major installation and architectural projects all over the world, with significant artistic and technical breakthroughs encompassing printmaking. These two great figures have inspired a whole new generation of visual artists, currently working with glass, both in terms of technology and poetic potential. Artists include Jeffrey Sarmiento, who explores cultural identity and the graphic image in glass, embedding layers of information in his intricately constructed objects, such as in Encyclopaedia (2016); Kathryn Wightman, who encapsulates imagery into three-dimensional forms, adding a delicate sensibility resulting in beautifully tactile objects such as in Carpet (2014) or Helen Mauer, who explores glass by casting light through it in installations, using the reflective and diffusive qualities of glass in tandem with overhead projectors and spotlights in innovative ways, as in Relay Overlay, (2012).

Considering this background, this research involves reclaiming glass as a historical printing substrate, both in reviving historical techniques based on the process of printed transfers and metal plate-based techniques, as well as evaluating the aesthetic qualities of historical glass negatives and magic lantern slides that display images through luminous phenomena.

INTRODUCING PHOTOLUMINESCENCE: BEYOND OPTICAL CONTEMPLATION TOWARDS ENGAGEMENT WITH THE VIEWER

Luminescence is a collective term used to describe the phenomenon of spontaneous light emission, which may be caused by chemical reaction (chemiluminescence), electricity (electroluminescence) or electromagnetic radiation (photoluminescence) (Laksmanan, 2007), amongst others. Photoluminescence, the feature of the materials used in this project, refers to a kind of luminescence that occurs when an input of radiation energy from the ultraviolet spectrum is converted to

Figure 5. From Left to Right: Two photopolymer plates, alongside their respective prints on paper and glass, with visible light (left) and UV light (far right). Photograph used for the production of the matrix, by Graciela Machado
Figure 6. Luminescence from the Red Planet (2018) by Ana Margarida Rocha. Wooden box, eyepieces, screenprint with photoluminescent sodalite enamel on glass, UV light, 35x35x35 cm. Installation in the FBAUP Museum, Porto, Portugal

an output of radiation energy in the visible spectrum (Addington and Schodek, 2005). It consists essentially of three stages: (1) the excitation of luminescent centres; (2) the storage of excited luminescent centres; (3) light emission. Luminescent materials are commonly solid inorganic materials intentionally doped with impurities such as rare earth ions that, when excited by photons create visible light (Ronda, 2007). They are widely applied in emissive displays, fluorescent lamps and LEDs.

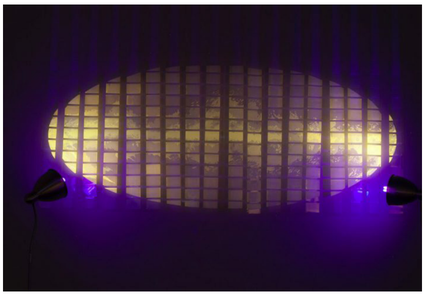

Figure 7

In recent years, material science research has focused on understanding the structure and characteristics of physical materials, and developing techniques for creating new types of compounds with characteristics of unprecedented nature, such as strength, durability, lightness, controllability, energy harvesting and sustainability (Wilson, 2002; Addington and Schodek, 2005; Shahinpoor, 2020). In addition to the aforementioned luminescent glasses doped with rare earth oxides, VICARTE, in collaboration with the chemistry research unit LAQV, is now exploring the development of new glass materials, using other elements which are more accessible and sustainable than rare earths. New aluminoborosilicate glass, without lead, infused with manganese and copper oxides, have already been produced to study energy transfer processes and possible technological applications in the project “From Inexpensive Raw Materials to New Luminescent Glass Materials” (2014). Furthermore, new luminescent zeolite pigments on glass substrates are being studied for potential use in design products, lighting devices or luminescent solar concentrators (Laia and Ruivo 2019).

Properties such as photoluminescence are widely exploited in the production of so-called smart materials, which are increasingly used in the fields of architecture and design (Ritter, 2007). These materials can respond dynamically to environmental stimuli, by changing their behaviour, for instance, their colour, shape or form (Ferrara and Bengisu 2014). In the art world, especially in installations (Bishop, 2015) and expanded print (Coldwell 2010), these qualities are most welcome as channels for engagement between objects, environments and the audience.

In 1970s the German artist Sigmar Polke was already experimenting and painting with light-sensitive materials (Halbreich et al., 2014), such as silver nitrate, commonly used in photography, which turns black over time when subjected to light. At the same time, German artist Konrad Lueg used phosphorescent paints on canvasses excited by a flashgun, so that a spectator passing between the screen and the flashgun would leave their shadow (Ritter, 2007). In 1990s, American artist Sharon Louden started to produced light-emitting artworks with phosphorescent materials, drawings, prints and installations, activated by the absence of light. They were shown in dark rooms where perspective fails and perception shifts, forcing the viewers into suspended states (Collins et al., 2006). Likewise, Philippe Parreno’s Fade to Black (2003) is a series of phosphorescent screen prints, presented in a space with lights programmed to go on and off, producing the strange effect of seemingly blank, white sheets, whose imagery suddenly

Figure 7. Interstellar Dust in the Milky Way (2018) by Ana Margarida Rocha. Screenprint on glass slides, UV light. 100 x 200 cm. Installation in the Alberto Sampaio Museum, Guimarães, Portugal

emerges, glowing vibrantly in the dark (Cherix, 2012). It is also worth mentioning the legacy of Light and Space Movement of 1960s and 1970s. Artists such as James Turrell, Robert Irwin, Dan Flavin, Bruce Nauman and Doug Wheeler, demonstrated how the use of technical and industrial advances in lighting devices could expand the boundaries of art practice and stimulate heightened sensory awareness in the receptive viewer. They applied mechanical and psychological effects of visual and haptic perception to their aesthetic experiments with light, through the manipulation of transparent, translucent and reflective materials creating phenomenological environments (Clark, 2011).

This project sought to demonstrate how the new photoluminescent materials, produced at VICARTE, may have relevant application in artistic projects addressing issues such as light, colour, perception, visuality, towards viewer's engagement.

PRINTING WITH PHOTOLUMINESCENCE ENAMELS ON GLASS

This research examines methods for the integration of an image on glass, through direct methods and decals, using photographic and autographic techniques, and using innovative photoluminescent materials developed in VICARTE. The methodology used involved studio-based experiments and sampling tests, in order to verify the ease of adopting identical printing conditions of screen printing, intaglio and photopolymer techniques on paper, and to evaluate the extent of techniques and whether respective marks produced were compatible with the application of luminescent enamels on glass. Since these materials have never been used before for printing, the aim was to develop ink formulas, review printing protocols and understand how quantities influence the degree of luminescence that might be achieved.

The first sequence of tests analyzed three different photoluminescent compounds: aluminoborosilicate glass doped with copper oxide; aluminoborosilicate glass doped with manganese oxide; and sulphur sodalite zeolite composite (Figure 1).

To produce the inks, the materials were reduced to a fine powder (about 10μm), using an electrical agate mortar (Mortar Grinder RM 200, Retsch), and then mixed with a fluid binder for screenprinting Decoflux WB for the production of temperature-resistant inks (550ºC – 750ºC) for printing on glass. The optimum mixing ratio of powder to binder was between 100 weight parts of colour powder and 50-100 weight parts of screenprinting medium. Direct screenprinted depositions were made on the surface of the glass with these three different photoluminescent compounds. The ink was pulled evenly across a screen mesh (terylene 90T) using a squeegee to flood the screen, printing directly on the glass surface. The samples were fired in the kiln in cycles ranging from 550º to 600º C, with the heat increased 100ºC per hour and remaining at final temperature for 30 minutes. The film obtained with the copper oxide doped glass showed up colourless under visible light and became white under 256 nm UV light. Manganese oxide doped glass showed up colourless under visible light and became reddish-pink under 256 nm UV light. Sulphur-zeolite composite (sodalite) showed up yellowish white and revealed a strong photoluminescence intensity with colour emission extending between the yellow-orange, orange, and orange-red range, depending on the sulphur content (Ruivo et al., 2018) under a 365 nm UV lamp. As presented in Figure 2, the samples were made by consecutively overlapping three layers of screenprinted paint, showing a progression, from light to dark when single-fired in the kiln. Multi layering was tested to evaluate different degrees of luminescence and colour emission achieved with thicker layers. Comparative tests show that direct screenprinting on glass with photoluminescent materials allows for uniform layers of paint which translate into strong colour emission, especially if working in layers. Ink preparation, handling and drying times are simple and identical to printing with a water-based screenprinting ink processes.

The second sequence of tests attempted to find the compatibility of the photoluminescent sodalite material with the delicate effects of intaglio printing, as shown in Figure 3. Hand engraved copper plates samples were produced with drypoint, burin, roulette and mezzotint. Copper plates were also etched with iron perchloride using marks achieved by etching, hard ground, spit bite and sugar lift techniques. In the inking process, sodalite powder was mixed with a more viscous binder, Charbonnel heavy oil for etching, to achieve an appropriate ink consistency for prinring (Hoskins, 2004), in the proportion of 70%-80% pigment, to 30%-20% binder.

Due to the rigidity of the glass matrix, direct printing was not possible. Instead, indirect printing was achieved through transfer printing, also known as decals. This process involves the printing of an engraved metal plate with glass enamel inks, onto a paper, previously prepared with a soluble coating, and then sealed with lacquer. To apply the decal to the glass surface, the carrier paper is dipped in water for a few minutes. During this time, water dissolves the paper gum, causing the waterproof thermoplastic film, or lacquer, to slide, bringing the image with it. Then the decal is placed on the glass surface, discarding the base paper, and removing all the water and air bubbles underneath. The thermoplastic film ends up completely glued to the glass.
Once dried, the glass is fired, the thermoplastic film burns, and the enamel melts, creating a permanent bond to the substrate. Although commercial decals papers exists, industrial recipe formulas were used to produce handmade transfer paper, based on industrial recipe formulas and lithographic transfer paper formulas. Usually, to remove the maximum ink load from the metal plate, paper is moistened, and a press with felts is used to apply enough pressure to force ink from the plate. However, printing onto a gummed transfer paper is problematic, making it difficult to achieve an ideal print quality. Using a transfer paper requires more pressure and requires the metal plate to go through the printing press several times, to ensure that the entire ink load is transferred to the paper. To assess the amount of ink that was eventually transferred to the glass, comparative tests were done

with cotton paper and gummed paper. Transfer printing allows all the printed subtleties present on hand-drawn work in line engraving and tonal etching to be retain. Transfer printing also allows the printed image to be applied to three-dimensional glass. However, if the depth of the line is shallow on intaglio prints, faintly luminescent images result. Longer biting periods in the acid extend the amount of ink eventually transferred to the decal paper, and subsequently to the glass, as shown in Figure 4.

The third sequence of tests investigated photogravure using photopolymer plates to print on glass through decals with sodalite. Toyobo photopolymer plate was used, with a thickness of 1.2 mm: a combination of soft polymer on a hard steel backing. The tests analyzed different light exposure times using a photographic negative. The transferred digital image was printed in negative using a home laser printer on acetate, both with and without stochastic screens. The various matrices resulted in differently contrasting images and capacity for ink retention, versus matrices produced with double exposures, which had smoother greyscale images and less ink retention capacity. The legibility of the image was a balance between the density of points and their proximity. Inking protocols were similar to the intaglio tests described above, as well as being affected by the process of transfer from the paper to the surface of the glass. After firing the samples in the kiln, comparative analysis showed again that the grain and depth of the matrix was positively correlated to the transfer of ink and in turn luminescence, as shown in Figure 5. Whereas silkscreen print imagery uses a halftone strategy to translate the image into something which will be printed via a screen mesh, in etching with photosensitive photopolymer, instead of coarse halftone, fine detail images are closer to techniques such as photogravure. During tests, the physical outputs of both photographic techniques were compared mainly because subtleties and differences into the image are obvious when printed on paper. Although photopolymer is still based on a dot structure, the way it reproduces tone relies on the applications of varying thicknesses of ink which reproduce grey halftones. The plates exhibit a continuous tone.

The unique features of light-emitting images are discussed below from a conceptual realm in two installation projects of contemporary art, which seek to shape and modify visual experience through photoluminescence phenomenona.

LIGHT-EMITTING PRINTS: TWO INSTALLATION PIECES

Sight is subject to light. French philosopher Luce Irigaray wrote, ‘I see only through the touching of light’ (1993: 155). Through the language of light and photosensitivity that Irigaray builds, the idea of texture is key (Vasseleu, 1998). For Irigaray, vision is dependent on touch and in its texture, light has a corporeality. In this sense, using photoluminescent materials represents a unique opportunity for artists interested in issues such as light, colour, perception, visuality, hapticity and observer engagement. When an external light source from the ultraviolet spectrum irradiates these materials, there is a phenomenon of light re-emission in the visible spectrum. Printing with photoluminescent glass enamels produces light-emitting material and textural images where a tactile look (Barker, 2009) is requested. Also, the photoluminescent image is transitive because it responds directly to the conditions of the environment in which it finds itself. The ultraviolet radiation from a black light source in a darkened room creates the illusion of an image floating in the surroundings, with a spectral look. On one hand, the emission of light and brightness and de-materialization is familiar within contemporary technological culture and the ubiquity of screens and monitors. On the other hand, the materiality, the physicality and tactility of the print. Optic and haptic are combined. The application of the technological research described above culminated in the presentation of two installation pieces, in two collective exhibitions.

Luminescence from the Red Planet, (Figure 6) is a piece that addresses the subject-object paradigm and the centrality of the 'Scopic Regime of Modernity' (Jay, 1988) which privileges sight. The outside appearance of the object is that of a dark box, a cube, with two eyepieces that ask the subject-observer to peer into the box. Inside the box we can see a panorama of the surface of Mars, captured by NASA's Mars Rover called Opportunity. The image was screen printed with photoluminescent sodalite enamel on a glass plate and it is illuminated by a light source of ultraviolet radiation that causes the image to glow with a reddish-violet hue. This box alludes to the camera obscura, a model widely used in the 17th and 18th centuries to explain human vision and to represent the relationship of the subject with the outside world. This model, used as an instrument for scientific research, artistic practice or popular entertainment, has also persisted beyond the object, in a disposition of cultural practices, as an epistemological figure, a place of discursive formation. As noted by Jonathan Crary, what is crucial in the camera obscura is the observer's relationship to the unmarked and undifferentiated vastness of the outside world, and how its apparatus establishes an orderly cut delimitation of that field, opening the way for a disembodiment of vision (Crary 1992). This piece aims to highlight the way Modernity, as approached by Crary, has approached vision as a neutral transmission device, where light and transparency are synonyms of truth. Nowadays we have access to multiple content from the scientific explorations, directly provided by space agencies. These vision machines reposition vision on a plane detached from the human observer. These images have nothing to do with the position of an observer in real world and perceived by the eye. We look at places that our bodies have never witnessed physically, but which have a compelling influence and impact on our imagination.

Interstellar Dust in the Milky Way (Figure 7), is the second installation, from 2018, where light is simultaneously motif, means and material. The piece was presented in the Alberto Sampaio museum, in Guimarães, whose collection consists mainly of religious art, with important pieces from 14th, 15th and 16th centuries, from churches and convents from the region, dealing with symbolic representations of divine light. From the light of God to the light of the Cosmos, the piece was developed from information revealed by the Gaia Project, from the European Space Agency (ESA). The mission of the project was to chart a three-dimensional map of the Milky Way, thus revealing the composition, formation and evolution of our Galaxy. On April 25, 2018, ESA disclosed the most detailed map of our home galaxy to date, which includes the position, distance and motion data of nearly 1.7 billion stars. The information gathered includes brightness data on all 1.7 billion surveyed stars, the colour measurement of almost all of them, and for about 500,000 stars, how the brightness and colour change over time. With this background, a large map was laid out, segmented as a grid of 234 small images, screenprinted in a cumulative layering process of sodalite enamel, fired to the substrate (234 glass slides), and installed as a set, occupying the entirety of an interior room wall in the museum. Unlike the previous piece, here, the whole body of the observer is located inside the darkroom. The image refers to interstellar dust, which interacts with the electromagnetic radiation of the cosmos, in the same way that synthesized sodalite zeolite composites interact with UV light: each of the little grains, absorbing, reflecting and re-emitting light. The visitor enters the dark room and their eyes begin a process of accommodation to the darkness. Then, slowly, a spectral, floating image increases in brightness and imprints itself on the observer's retina, such that it gives rise to an afterimage, preserving and inscribing the effects of an earlier perception. Goethe addresses these issues in his "Theory of Colours", where he describes perceptual experiences in dark rooms and the physiological effects of light and dark and the phenomenon of afterimages (Goethe, 1840). These perceptual experiences seeks to show the impact of the observer's body on the process of vision, as a place of production of optical experiences. Working with light sources and light emission brings into play the subjective features of human vision and the direct impact of light on our body.

CONCLUSION

Artists working in science and technology face the dilemma of how to resolve having a foot in both worlds. On the one hand, artists are invited to help create new technologies and develop new possibilities. On the other hand, critical distance must be retained, using new technologies, to critically comment on the implications of its development. Mick Wilson makes an apt comparison of a collaborative research with the relationship between a host and a guest. The interdisciplinary involvement of the research artist can be thought of as the experience of a "guest" in the "host's" house. This approach clearly encourages us not to seek to become masters in someone else's home, but to learn something about it (Wilson, 2012). Wilson also warns of the importance of reflecting on these interactions and exchanges between "inside" and "outside", and the possibility for guests and hosts to become "critical friends", made possible by the strange and unstable reciprocity of rules of hospitality and ethos.

The same technologies that tend to blur the sense of time, space, and body, can be employed in practices that reflect on this unclear boundary and exemplify new ways of shaping meaning. Light is the physical phenomenon responsible for our visual perception and one of the most fundamental and powerful human experiences. Photoluminescent imaging is considered to have the potential to weaken ocularcentrism and emphasize the physicality and corporeality of light. Light-emitting printed images arise as an alternative that has potential to reestablish a more sensitive and embodied contact, where the eyes can also function as touch organs, in an involved and explorative reflection that associates the visual with the tactile, approaching the subject, the objects and the environment. These mysterious images mobilize empathy, interweave in our collective memory and ask for an active engagement from the observer.

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IMAGE GALLERY

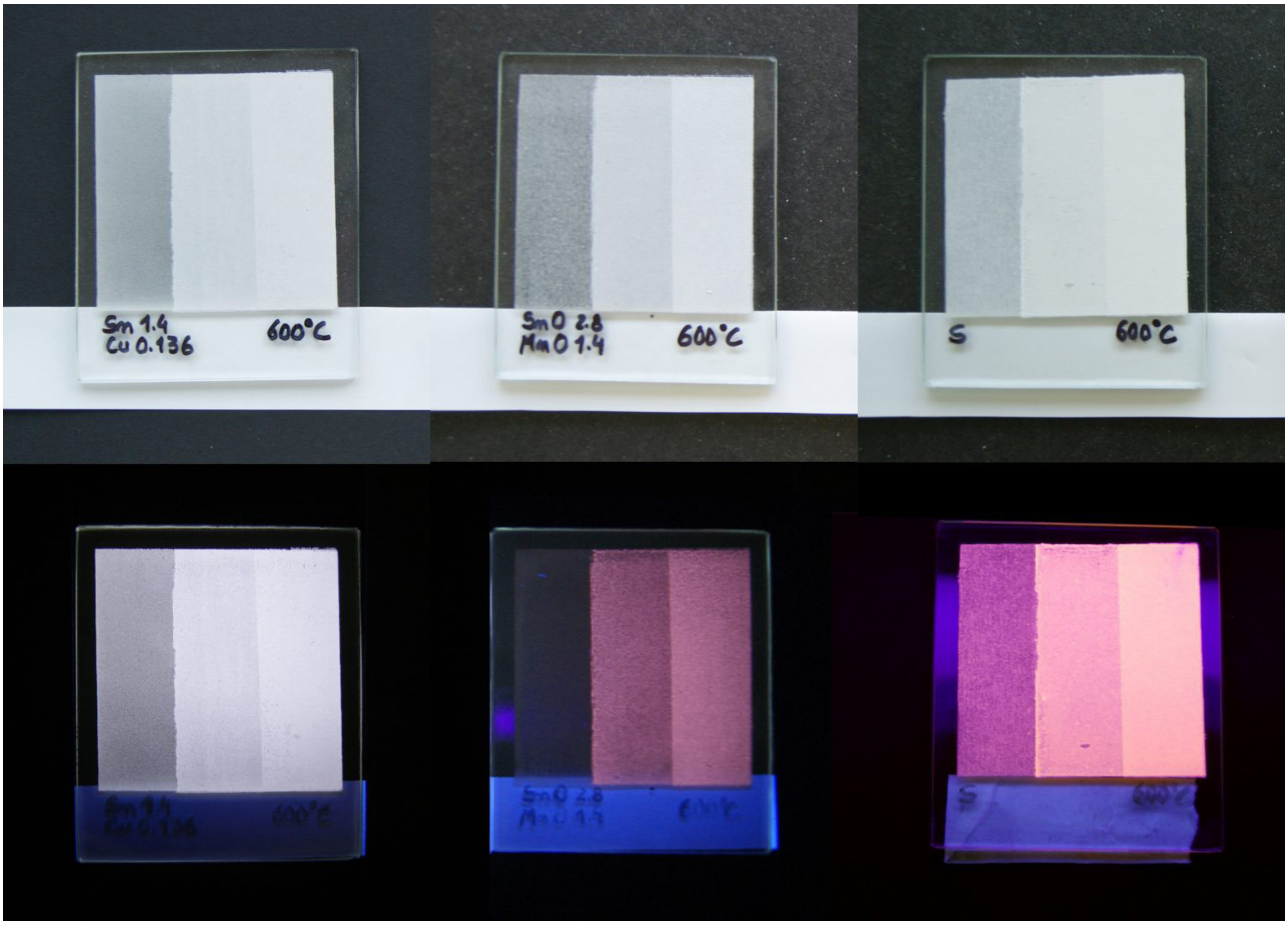
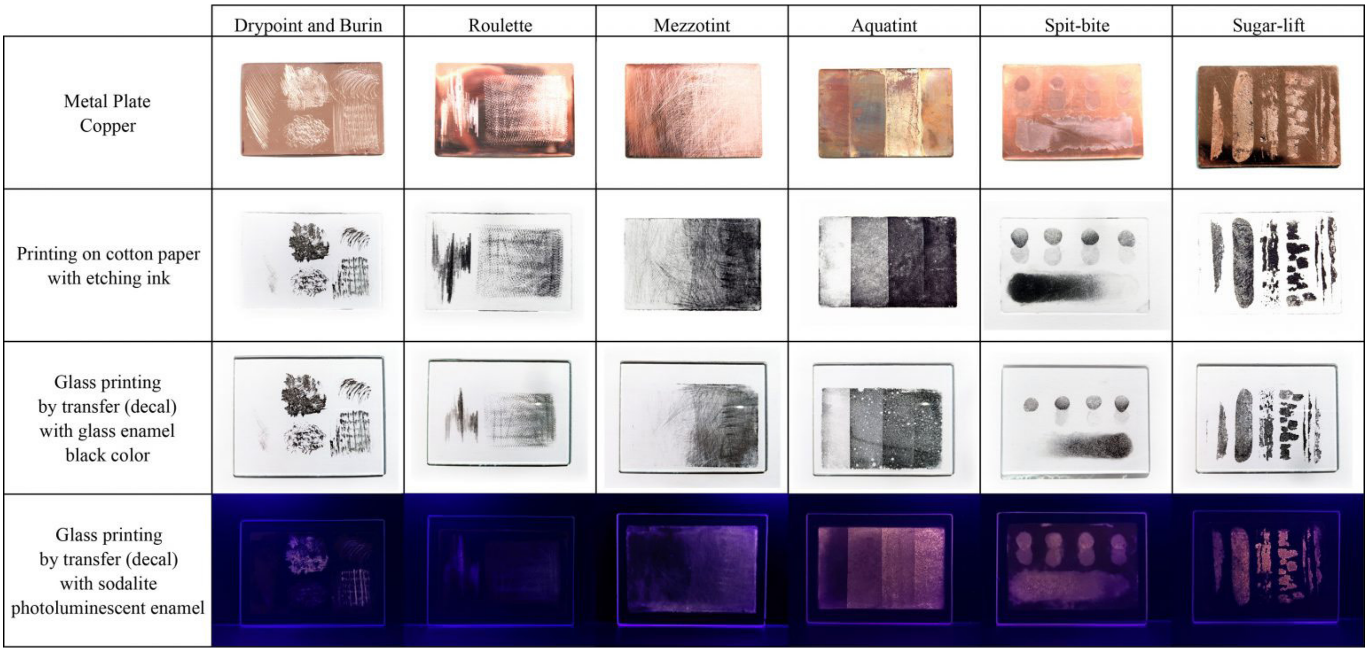


Figure 1. From left to right: equipment used to sodalite's synthesis: horizontal tubular electric furnace (TH1300, Termolab); aspect of sodalite, after synthesis, under visible light; aspect of sodalite powder, under visible light
Figure 2. Direct screen printed films depositions. From left to right: copper oxide doped glass enamel; manganese oxide doped glass enamel; sulphur zeolite composite. First row, samples viewed with visible light and bottom row, samples viewed with UV light



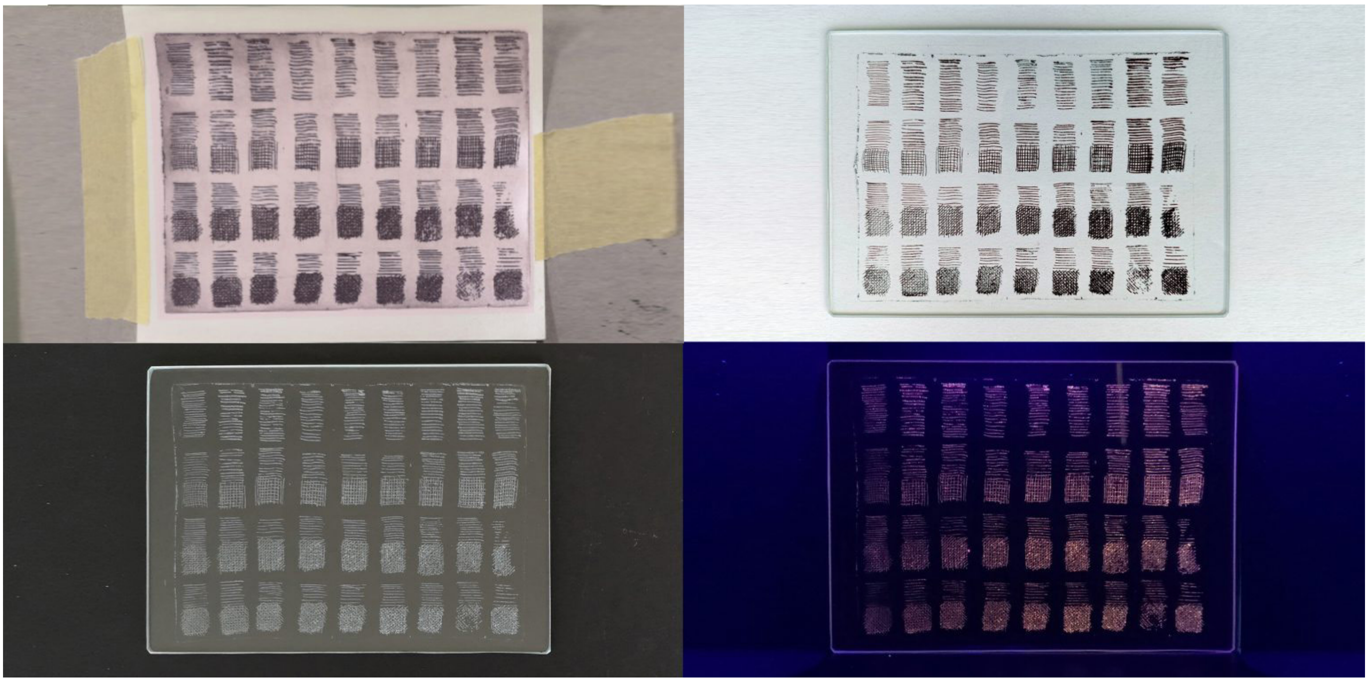
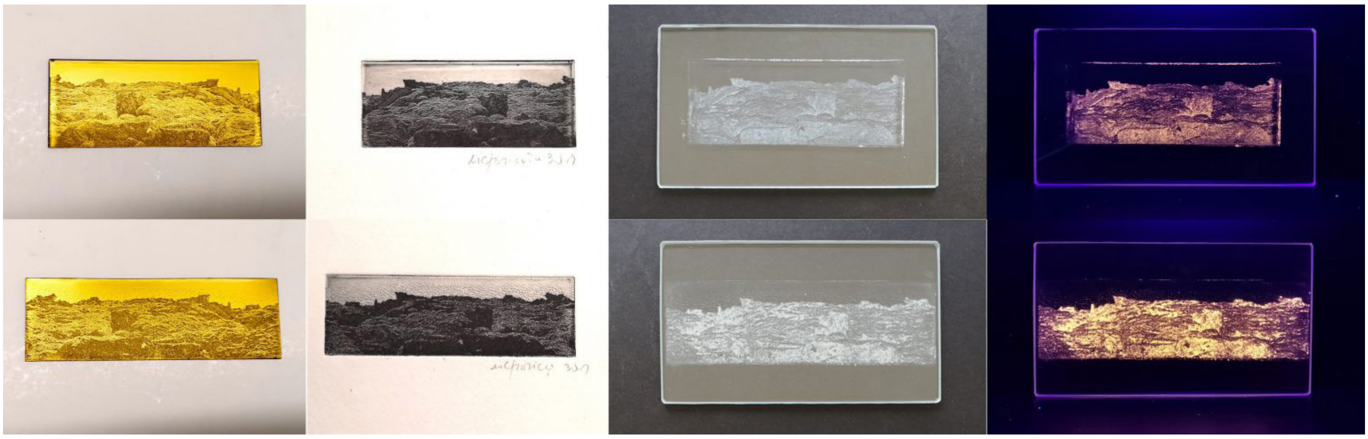
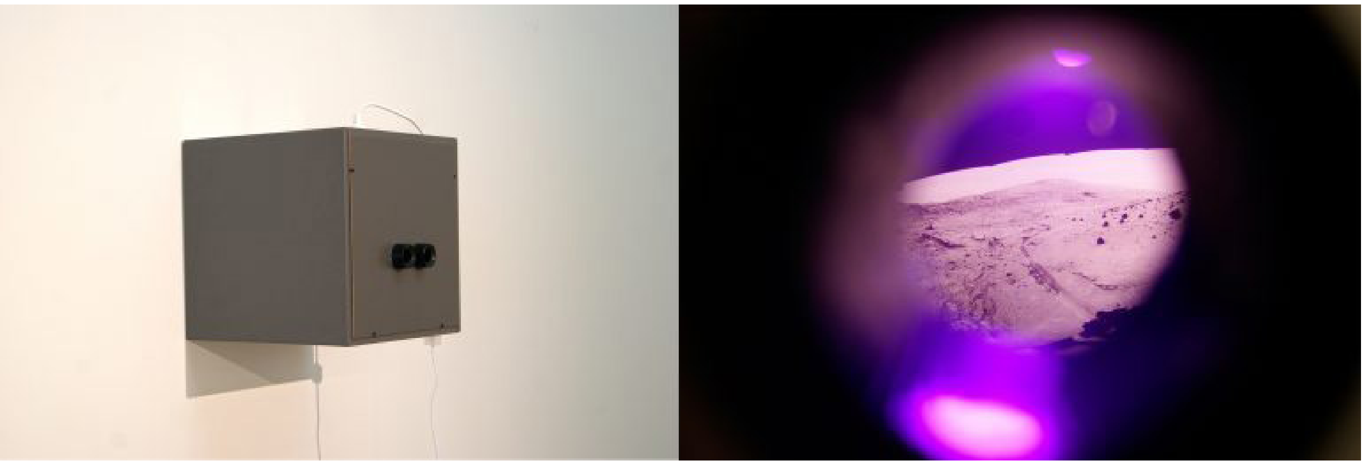


Figure 3. Intaglio samples. Views from the copper metal plates, printing on cotton paper, transfer printing on glass with black enamel and transfer print on glass with sodalite photoluminescent enamel

Figure 4. Line etching samples with different periods of time immersed in the acid. The nine columns correspond to the following exposure times: 6, 12, 18, 24, 30, 36, 42, 48, 54 minutes. At 54 minutes, the depth is about 0.5 mm. From left to right and top to bottom: printed decal with commercial black enamel; transfer print on glass; transfer print with sodalite on glass (visible light); transfer print with sodalite on glass (UV light)





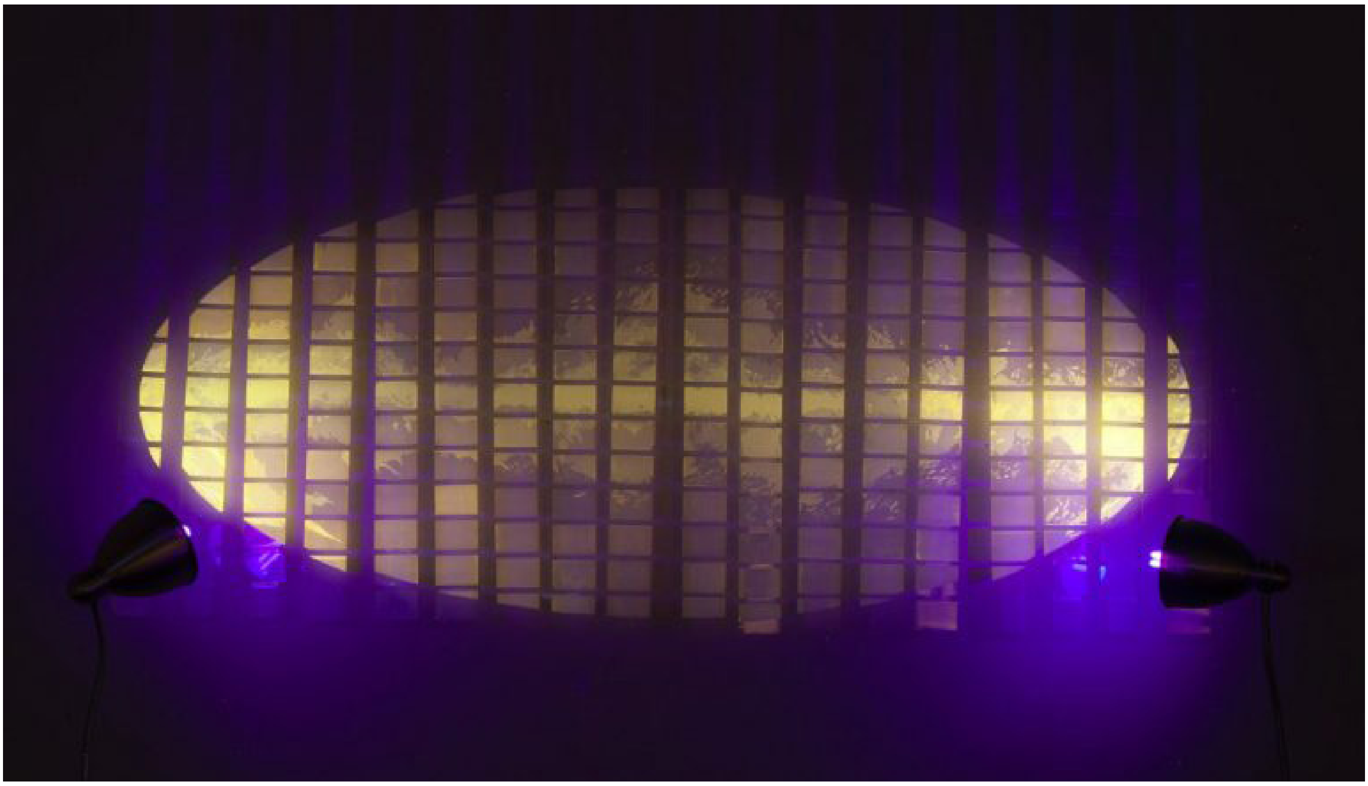


Figure 5. From Left to Right: Two photopolymer plates, alongside their respective prints on paper and glass, with visible light (left) and UV light (far right). Photograph used for the production of the matrix, by Graciela Machado
Figure 6. Luminescence from the Red Planet (2018) by Ana Margarida Rocha. Wooden box, eyepieces, screenprint with photoluminescent sodalite enamel on glass, UV light, 35x35x35 cm. Installation in the FBAUP Museum, Porto, Portugal