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Original article

First experiments for the use of microblasting technique with powdered cellulose as a new tool for dry cleaning artworks on paper

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A B S T R A C T

This research evaluates the use of microblasting technique with powdered cellulose as a new tool for dry cleaning documents. Different cleaning tests were conducted on three documents with different properties following this new approach and the results were compared to those obtained with traditional dry cleaning with erasers. In order to assess changes caused to the supports, the treated documents were examined both before and after cleaning with optical and 3D stereomicroscopy, SEM-EDS and spectrophotometry. The results allow the conclusion that microblasting with powdered cellulose is a feasible technique to remove surface dirt or grime on paper documents. This research proves that the new use of the technique does not entail changes to the surface properties of the treated supports. Moreover, powdered cellulose is chemically stable and compatible with paper documents, preventing negative long-term effects derived from the presence of rubber residues that may remain in paper fibres when using erasers in dry cleaning treatments.

1. Research aims

This research addresses the use of microblasting as a new tool for the dry cleaning of paper documents. The research pursues two main goals: on the one hand, the proposed methodology must preserve the original texture of the support without causing any changes to the paper surface during the treatment; on the other hand, the abrasive should be chemically stable and compatible with cellulose in order to avoid long-term effects or future exposure to volatile organic components (VOCs). Also, cleaning results ought to be at least up to the standard of other dry mechanical cleaning methods currently used by conservators.

2. Introduction

As with other heritage materials, dry cleaning of paper documents is a very delicate intervention because of the risk of damage that can be caused. The methods available are diverse and all of them present advantages and disadvantages. Usually based on preliminary tests, the conservator selects the most appropriate techniques for each situation depending on the properties, characteristics and conservation state of the document, as well as the type of dirt and the degree of adhesion to the substrate.

Dry cleaning with different tools (paint brushes, vacuum low pressure, etc.) is quite common in these situations although the use of erasers is one of the most widespread methods. Usually, the objective when using erasers is to remove small superficial deposits such as dust, soil or grime by a mechanism of friction conducted by sliding the eraser on the dirt settled on the substrate. Three basic types of erasers are used according to their composition: vinyl (usually containing polyvinyl chloride and plasticizers), factice (sulphur vulcanised vegetable oils), and rubber (may include other additives in composition such as drying oils, sulphur or abrasives). Other substances are also used in dry cleaning such as starch and silicone-based erasers [1–4]. The technique has *a priori* two major drawbacks: on the one hand, the change of texture properties of the support [5,6] due to the friction mechanism carried out on the surface; on the other hand, eraser residues may have a negative effect on the stability of the substrate in the long-term, as erasers usually contain sulphur, hydrochloric acid, plasticizers, drying oils, abrasive materials, etc. [7–11]. In recent years, laser cleaning has been tested on paper documents [12–16] as an alternative to erasers, although the chemical changes or mechanical alteration that might be produced is still being evaluated. Furthermore, laser equipment is not always available to the restorer.

In this research abrasive microblasting – a mechanical technique also used for cleaning other heritage materials – has been tested as

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a tool for dry cleaning documents in order to minimize mechanical damage caused by the treatment and to reduce the effects that eraser residues can generate on paper documents. Traditional highly hard abrasives used in other assets, such as synthetic silicates, have been replaced by powdered cellulose due to its affinity in composition to the paper supports. Microblasting involves not only the mechanism of friction (as in eraser cleaning) but also an impact mechanism. With the aim of minimizing impact and friction of cellulose particles on the surface while microblasting, parameters of pressure and angle were modified during the treatment. To evaluate the results, optical, topographical and colour analysis have been conducted with several techniques.

3. Materials and methodologies

Different mechanical cleaning tests were conducted and the results compared with both traditional manual eraser cleaning and powdered cellulose microblasting. Tests were performed on the reverse of two prints located at the conservation laboratory of the Fine Arts Faculty at the University of Barcelona and on the reverse of a print by Eduardo Chillida from private collection (CONCA Art Gallery, San Cristóbal de la Laguna, Tenerife, Canary Islands, Spain).

The first document (referred to as Document 1) is a chalcographic engraving that measures 24 cm × 41.8 cm size, 31 μm thick, 129 g/m^2 grammage, and shows a very fine laid finishing. The image reproduces the high relief located at the attic on the east facade of the Constantine Arch in Rome representing a scene of the Trajan's Dacian Wars. The support is a machine-made paper with transverse fibre direction, uniform distribution of the chemical pulping and without watermark. There are no references about the date, title and author of this engraving, but taking into account the characteristics of its constitutive materials, the artwork was in all probability printed later than the second half of the 19th century. The condition is poor and it presents damp stains, residues of paint and some degree of acidity.

The second document (referred as Document 2), another chalcographic engraving, is a reproduction of an etching executed by Johann Simon Negges (1726–1792) after the Göz Gottfried Bernharhd print entitled *Salutantem resalutat Deipara*, published in Augsburg in 1764 as the 18th image of the series *Historia Vitae S. Bernardi.*

Based on the printing characteristics of this reproduction, Document 2 probably dates from the first half of the 20th century. It measures 21.5 cm × 16.5 cm size, 24–31 μm thick, 140 g/m^2 grammage and also consists of a laid paper. The support is a handmade paper with irregular distribution of the pulp, and without watermark. Its condition is poor; it shows damp stains and structural deformations.

The third document (referred as Document 3) is a xylography printed with black ink on "auvergne" paper entitled "Osasun" by Eduardo Chillida, in an informalist style [17]. The work was published in 1974 by Maeght, at the Fequet et Baudier atelier in Paris [18,19]. The artwork measures 32 cm × 38.5 cm, 50 μm thick, and is made on a semi-mechanical pulping paper with a watermark in the bottom right-hand corner of the sheet held by four chain lines spaced by 3.5 cm. Handwritten annotation for the print run (5/50) and the signature are also present in this corner of the sheet. Regarding its condition, it is important to note the presence of superficial dirt and stains of diverse nature, including foxing. A slight decolouration can also be observed due to cellulose oxidation, which is more intense on the reverse.

Using the standard procedure, the documents were photographed and some initial analyses on their conservation conditions were conducted too before performing the cleaning tests.

In order to reproduce traditional dry cleaning treatments, a Milan 403 eraser was used. This is an eraser frequently used by conservators because of its abrasiveness, tackiness and stiffness. According to the manufacturer references [20], its composition is synthetic rubber, although minority compounds and other information are not specified. On Documents 1 and 2, tests were performed by sliding manually grated eraser on the surface of the paper with cotton wool reproducing delicate cleanings. On the Chillida print, tests were conducted in two stages on the same area using manually grated eraser in a first stage and finishing the cleaning with the eraser applied directly from the solid block.

For the microblasting tests, powered cellulose Arbocel® BE600-30PU of 30 μm, from J. Rettenmaier & Söhne, was used as abrasive. Technical data indicates that this material is composed of cellulose 98%, with average fibre lengths of 40 μm, pH 7 ± 1 and bulk weight of 220 g/L. Cellulose fibres were blasted with a microblasting CTS 5/B, footswitch operated, with a straight tungsten carbide nozzle of 0.7 mm diameter. Other equipment used included a silenced compressor of 1.5 CV and a dehumidifier filter to reduce the humidity of the compressed air and the clumping of the cellulose. The treatment was made in a sandblasting cabinet Box CTS 4 with environmental dust collector. On Documents 1 and 2, the microblasting was made once, and on the Chillida print, twice. After all the erasing and microblasting tests, surfaces were cleaned with a low suction vacuum cleaner eliminating the possible residues that may remain.

In order to evaluate surface changes, cleaning degree and residues on the support, magnifying optical techniques were used. Firstly, surfaces were analysed with a stereomicroscope Olympus SZX12 equipped with a digital photographic camera. Documents were illuminated at 45° angle transmitted by optical fibre and photographs were taken before and after cleaning at ×16, ×50, and ×90. This simple technique combined with the grazing light allows the observation of surface changes and residues after cleaning.

With the same purpose, samples were also observed with a Leica M165C stereomicroscope equipped with a Leica Stereo Explorer visualizing and measuring in 3D. In this case, an upright illumination was used. With this technique, besides obtaining high-resolution images, the topography of the treated and untreated surfaces was observed in 3D, obtaining roughness profiles that help to understand the cleaning effects.

For further study, samples were taken to analyse topography and elemental composition of the paper supports after cleaning with an environmental scanning electron microscope ESEM Quanta 200 FEI, XTE 325/D8395. The working distance was 10 mm, the voltage 20 KV, and the pressure was lower than 134 Pa. This technique provided in-depth information on the surface of the samples.

Finally, colour changes were analysed with a spectrophotometer Konica Minolta CM-2600d as an indicator of the cleaning achieved after the treatments. The reflectance measurements were taken with the specular component included (SCI) in areas of 8 mm^2 with illuminant D65, and 10° observer. Three measurements of each spot were taken to report statistic data.

After one year of storage in archival quality paper folders under constant humidity and temperature conditions with no exposure to light, colour measurements were conducted on the same spots with the same parameters in order to monitor possible modifications on the treated surfaces.

4. Experimental data

It is well known that the use of erasers may cause clumping and disordering of paper's cellulose fibres. As no references were found, and in order to observe the type of damage produced with powdered cellulose microblastig, some preliminary tests were carried out with a 200 kPa (29 psi) pressure for 5 seconds on a paperboard