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## **Flexible Polyurethane Ester Foam Consolidation: Preliminary Study of Aminopropylmethyldiethoxysilane Reinforcement Treatment**

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### **Abstract**

Museum artifacts made of polyurethane foam are affected when the foam loses its mechanical properties. While effective treatments are available for polyurethane ether foams, no convenient consolidation treatments exist for polyurethane ester foams. One possible solution is aminopropylmethyldiethoxysilane (AMDES), which has already been used successfully for deacidification and consolidation of paper. To explore this possibility, we tested AMDES on industrial flexible polyurethane ester foam samples. Various concentrations of AMDES solutions were applied to unaged samples and to samples that had been artificially aged hydrothermally. Mechanical properties were studied using a compression force deflection test, and the results showed that AMDES treatment improved the resistance to compression of both aged and unaged foams. To investigate the AMDES distribution in the thickness of the samples, Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM) were used. The colour of the samples was monitored before and after consolidation to assess the impact of the AMDES on the visual aspect of the treated samples, and the colour difference was negligible for all the samples treated. These results suggest that the AMDES could be an efficient solution for the consolidation of polyurethane ester foams.

### **Titre et Résumé**

#### **Consolidation de la mousse souple de polyuréthane à base d'ester : étude préliminaire d'un traitement de renforcement à l'aminopropylméthyldiéthoxysilane**

Les objets de musée en mousse de polyuréthane se dégradent lorsque la mousse perd ses propriétés mécaniques. Bien que des méthodes efficaces pour traiter les mousses de polyuréthane à base d'éther sont disponibles, il n'existe pas de traitement de consolidation adéquat pour les mousses de polyuréthane à base d'ester. Les solutions permettant de régler ce problème comprennent, entre autres, l'utilisation d'aminopropylméthyldiéthoxysilane (AMDES), un produit qui a été employé avec succès pour effectuer la désacidification et la consolidation du papier. Afin de valider la pertinence de cette approche, nous avons mis à l'épreuve des échantillons de mousse souple de polyuréthane à base d'ester commerciale traités à l'AMDES. Des solutions d'AMDES de diverses concentrations ont été appliquées sur des échantillons non vieillis et des échantillons ayant subi un vieillissement hydrothermal artificiel. Les propriétés mécaniques des mousses ont été étudiées en réalisant des essais de flexion sous compression : les résultats indiquent que le traitement à l'AMDES améliore la résistance à la compression des mousses vieilles et non vieilles. La spectroscopie infrarouge à transformée de Fourier (IRTF) et la microscopie électronique à balayage (MEB) ont servi à étudier la répartition de l'AMDES dans toute l'épaisseur des échantillons. La couleur des échantillons a été déterminée avant et après le

traitement de consolidation, afin d'évaluer les effets de l'AMDES sur leur aspect : tous les échantillons traités présentent une altération de la couleur négligeable. L'ensemble des résultats semblent donc indiquer que l'utilisation de l'AMDES pourrait constituer une solution efficace au problème de consolidation des mousses de polyuréthane à base d'ester.

## Introduction

Nowadays polyurethanes (PUR) cover a very large family of polymers widely used for common life and industrial objects. Their flexibility and diverse chemistry allows the synthesis of products that exhibit different physical properties, from hard plastics to soft elastomers. Because of their multiple applications, since the 1960s, PURs attracted artists and designers, who utilized them for sculptures, paintings, design furniture, textiles and accessories (Williamson 1999; Waenting 2008).

PUR foams deteriorate rapidly; the effects of degradation can appear after 20-30 years of natural ageing. Consequently, conservation issues mainly related to the loss of their mechanical properties now affect these artefacts. The main symptoms of degradation are discolouration, loss of flexibility and crumbling, which occur under influence of moisture, heat and light (Szycher 1999). During the degradation process, PURs undergo both chain scission and cross-linking phenomena. For the two main families of PUR ester and PUR ether several studies demonstrated that the esters are more sensitive to hydrolysis while the ethers are more sensitive to oxidation (Kerr 1993; Wilhelm 1997; Wilhelm 1998; Szycher 1999).

Several studies concerning degradation and conservation strategies for PUR foams used by artists are reported in the literature (Lorne 1999; Rodrigo 1999; van Oosten 2002; Lovett 2004; Colombini 2008). However, while Van Oosten (2004) reported that impregnation of PUR ether foam with a mixture of Impranil DLV and vitamine E (an anti-oxidant) inhibits the photo-oxidation and gives flexibility to PUR ether foam, no convenient consolidation treatment exists for PUR ester foams, and curators of modern and contemporary art are still seeking solutions to extend the lifetime of works of art made from this material.

The 3-aminopropylmethyldiethoxysilane (AMDES), already used for deacidification and consolidation of paper (Dupont 2010), was chosen to be tested on industrially flexible PUR ester foam samples. For paper conservation the use of aminoalkylalcoxysilanes (AAAS) provides an alkaline buffer on the cellulosic network, improves the mechanical resistance of the paper and remains effective even after ageing (Ipert 2006). AMDES was thus chosen to be tested on a series of aged and unaged PUR ester foam samples to evaluate its consolidation effect on PUR.

This paper will present the results of the analysis performed on treated samples in comparison with untreated ones. Colorimetric measurements, scanning electron microscopy (SEM) images, stress/strain compression curves and Fourier transform infrared (FTIR) spectra will be discussed to evaluate the effectiveness of AMDES treatment for PUR ester foam consolidation.

## Methods

### Samples

New Dimension Industries LLC (NDI LLC) supplied the foam used as a reference. It is an open-cell flexible blue foam with a density of 30kg/m<sup>3</sup>, PUR ester formulated with 2,6- and 2,4-toluenediisocyanates (TDI) and poly[di(ethylene glycol) adipate]. Nowadays this formulation is the most common in PUR ester flexible foam industry, and from an internal study on foams from museum collections it was found that PUR ester flexible foams were usually formulated with TDI isocyanates. The foam was pre-cut by NDI LLC in cubic regular samples (50 mm x 50 mm x 30 mm) suitable for compression tests.

### Artificial ageing

Artificial thermal ageing has been performed at 90 °C and 50% RH for a period of 21 days in an environmental chamber Vötsch HC0020. The ageing conditions were chosen to obtain samples closely reproducing common conditions of naturally aged foams.

### AMDES treatment

Solutions of AMDES in hexamethyldisiloxane (HMDS) solvent were prepared at different AMDES concentrations (2.5%, 5% and 10% vol/vol). Each solution was used to treat aged (AMDES 2.5% aged, AMDES 5% aged, AMDES 10% aged) and unaged samples (AMDES 2.5%, AMDES 5%, AMDES 10%). HMDS solvent alone was also tested on aged (HMDS aged) and unaged samples (HMDS). The foam samples were weighed and immersed for 24 hours in each solution using closed polypropylene containers. After immersion the samples were dried under vacuum for 6 hours and once completely dried they were weighed once more in order to determine the AMDES uptake.

### Colorimetric measurements

The CIE L\*a\*b\* coordinates were measured with a portable sphere spectrophotometer X-Rite SP64 using the following set-up parameters: 4mm measurement area (6.5mm target window), illuminant type D65, 10° standard observer angle and specular component included (SPIN). The measurements were repeated on the top surface of two replicate samples at 5 different locations on each, with the mean value for L\*, a\* and b\* of the 10 measurements reported in Table 2. The mean values were used to calculate the colour differences between the treated and the reference samples (unaged or aged) using the standard colorimetric formulae reported hereafter according to the ASTM D 2244-93.

$$\Delta C_{ab}^* = \sqrt{(a_1 + b_1)^2} - \sqrt{(a_2 + b_2)^2}$$

and

$$\Delta E_{ab}^* = \sqrt{((\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2)}$$

The foam flexible structure is deformed by the weight of the spectrophotometer if it is applied directly in contact with the foam surface; this deformation could affect the chromaticity coordinate value measurements (Binnie 2011). Therefore to avoid deformation of the cell structure of the foam, for both unaged and aged samples, a rigid black box with a hole of 53x53cm on the top was used as an additional device to the spectrophotometer X-Rite. The samples were in-

serted in the central hole of the box so that the portable spectrophotometer positioned onto the box could be in close contact with the foam surface and analyse it without any deformation.

### **Mechanical tests**

Mechanical properties have been studied by Compression Force Deflection Test according to the ASTM D 3574-03 test C method using an Adamel Lhomargy DY.20 B tensile/compression instrument. Two specimens per sample were tested and the value reported is the mean value of those observed. Every specimen was compressed 50% of its thickness (15 mm) at 50 mm/min and kept under compression for 60 seconds. The entire stress/strain curve was recorded and the final force after 60 seconds determined.

### **SEM imaging**

Backscattered electron images of the foam surfaces before and after treatment were obtained with a SEM Jeol JSM-5410LV. The samples were stuck with a carbon adhesive on aluminum sample holders and coated with gold to a thickness of approximately 300 Å. The analyses were performed at a working distance of 26 mm and accelerating voltage of 20 kV.

### **FTIR spectroscopy**

The FTIR spectra were recorded on a Nicolet 6700 spectrophotometer, equipped with a diamond ATR macro-system (Smart Endurance) scanning from 600 to 4000  $\text{cm}^{-1}$ , 36 scans were recorded for each spectrum at a resolution of 8  $\text{cm}^{-1}$ . To identify AMDES infrared absorption bands, a reference polymerized monomer solution was used.

## **Results and Discussion**

### **AMDES uptake**

The AMDES uptake values obtained after treatment show that higher concentration of AMDES in solution results in larger uptakes (Figure 1). In addition, aged samples always show larger uptakes than unaged samples (except for those treated with pure HMDS). This uptake difference between aged and unaged foams could be explained by AMDES higher affinity to hydrogen bonding with carboxyl groups (Souguir 2011), which are formed by hydrothermal degradation processes.

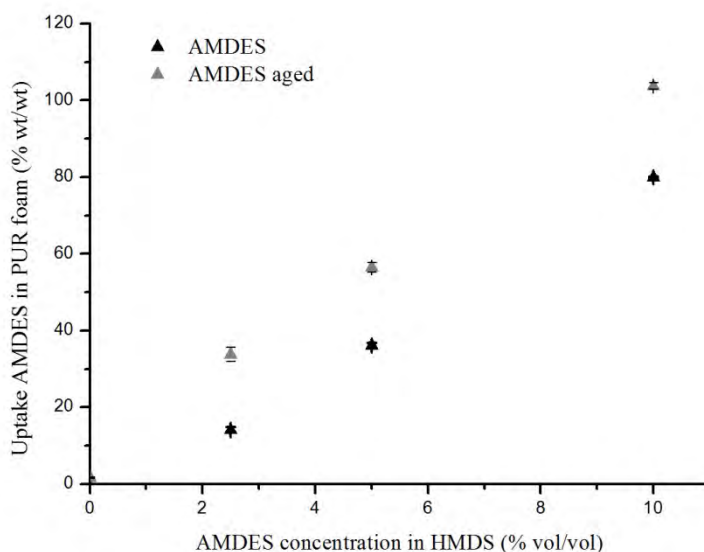


Figure 1. Uptake of AMDES in the foam samples (% wt/wt) as a function of the concentration of AMDES in HMDS (% vol/vol)

## Colorimetric measurements

An important issue of conservation treatments dealing with art works is the impact of the treatment on the original colour of the object treated. For this reason it is important to minimize the colour change due to the addition of a new material. The colorimetric coordinates  $a^*$  and  $b^*$  of the CIE  $L^*a^*b^*$  colour space measured on the sample surface are represented in Figure 2. Table 1 reports the values of  $L^*$ ,  $a^*$ ,  $b^*$ , the metric chroma difference  $\Delta C^*_{ab}$  and the total colour difference  $\Delta E^*_{ab}$ .

### Unaged samples

The unaged reference sample has  $a^*$  and  $b^*$  value of -15.23 and -31.15 respectively, corresponding to a blue hue.

After treatment, unaged samples show a small colour difference between treated and reference samples not readily visible. The change of metric chroma value is essentially the same for all unaged treated samples ( $\Delta C^*_{ab}$  values between -0.83 and -1.62), while the lightness of the colour rises with the increasing AMDES concentration. The HMDS treated sample, compared to the reference sample, has a  $\Delta E^*_{ab}$  less than 1 unit, therefore no difference in colour can be seen before and after pure HMDS treatment. The AMDES treated samples show a trend of higher  $L^*$  values with higher AMDES concentrations values. The consequence of this lightness increasing is highlighted by  $L^*$  values between 47.31 and 50.96.

### Aged samples

The aged reference sample shows severe discolouration and hue change from blue to greenish-blue as a consequence of hydrothermal ageing highlighted by  $a^*$  and  $b^*$  values of -19.76 and -13.45 respectively.

Aged treated samples show higher  $\Delta E^*_{ab}$  values than unaged treated samples, the difference in colour between aged treated and reference samples is visible when samples are compared side by side under natural illumination. Nevertheless, as mentioned in ASTM D 2244, the texture of the foam may hide the difference in colour appearance. The colour of the aged reference and HMDS-treated samples have significantly lower  $b^*$  values than the aged samples treated with AMDES, consequently they appear less saturated in chroma than the aged AMDES treated samples. The AMDES treatment applied to aged samples causes a colour shift in the aged treated samples such that the  $b^*$  values increase in a direction that results in a colour trend back towards the original colour of the reference. The  $a^*$  and  $b^*$  values of aged AMDES treated samples show a trend towards higher colour saturation with increasing AMDES concentration. As for unaged treated samples, the aged treated samples become lighter with increasing AMDES concentration.

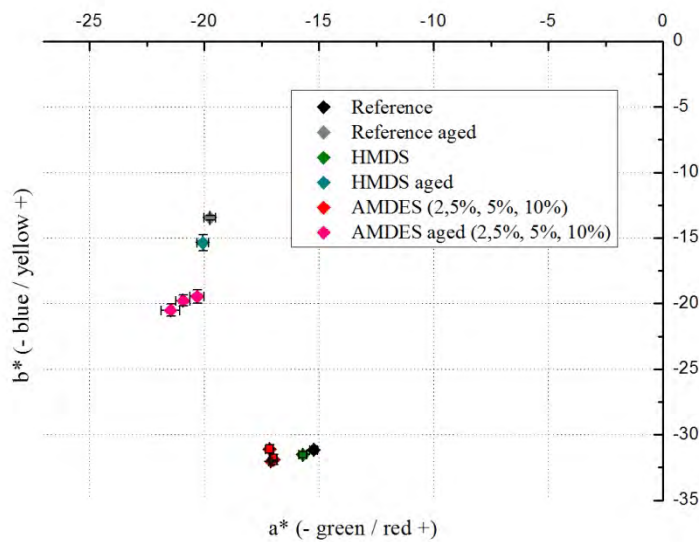


Figure 2. Representation of the colorimetric coordinates CIE  $a^*$  and CIE  $b^*$  of CIE  $L^*a^*b^*$  colour space (each value is the average of the measured values from 2 samples with 5 measurements on the top surface of each sample and the error is expressed as 1 standard deviation)

Table 1. Colorimetric coordinates of CIE L\*a\*b\* colour space (each value is the average of the measured values from 2 samples with 5 measurements on the top surface of each sample and the error is expressed as 1 standard deviation)

	L*	a*	b*	$\Delta C^*_{ab}$	$\Delta E^*_{ab}$
<b>Unaged samples</b>					
Reference	47.31 ± 0.61	-15.23 ± 0.17	-31.15 ± 0.19	—	—
HMDS	47.78 ± 0.87	-15.7 ± 0.16	-31.53 ± 0.23	-0.54	0.98
AMDES 2.5%	49.95 ± 0.32	-17.09 ± 0.09	-32.02 ± 0.09	-1.62	3.34
AMDES 5%	50.2 ± 0.61	-16.98 ± 0.16	-31.89 ± 0.39	-1.45	3.48
AMDES 10%	50.96 ± 0.45	-17.15 ± 0.16	-31.1 ± 0.32	-0.83	4.13
<b>Aged samples</b>					
Reference	43.95 ± 0.36	-19.76 ± 0.25	-13.45 ± 0.19	—	—
HMDS	44.01 ± 0.51	-20.06 ± 0.25	-15.35 ± 0.62	-1.36	1.97
AMDES 2.5%	46.49 ± 0.60	-20.31 ± 0.32	-19.46 ± 0.5	-4.23	6.57
AMDES 5%	46.3 ± 0.46	-20.92 ± 0.30	-19.76 ± 0.43	-4.87	6.83
AMDES 10%	47.78 ± 0.99	-21.46 ± 0.40	-20.5 ± 0.45	-5.77	8.21

## Mechanical tests

For polymer foams compressive properties are usually tested to evaluate the mechanical features of the material. For this reason, a compression force deflection test (ASTM D 3574-03) has been used to evaluate the mechanical properties evolution of PUR ester foam after AMDES treatment. In Figure 3 and Figure 4 stress-strain diagrams of treated and untreated samples are reported. In Table 2 stress values are reported for each sample at five different strains to provide the measurement uncertainty. All the curves presented exhibit a first domain with a linear elastic behaviour which ends with a limit load maximum (yield strength). This first linear part is followed by a large plateau which involves either plastic deformation or rupture of the cell walls. Rupture of the cell walls is occurring after compression of the aged reference sample. After AMDES treatment, both aged and unaged foams show a stiffening effect on the initial modulus, the slope of the curve between 0 and 0.05 mm/mm becomes steeper. They also show an increase of the maximum load, the stress at yield point increases. This results in stiffer materials more resistant to compression. Furthermore the whole stress plateau moves to higher stress values, corresponding to an increase of the whole toughness. The reinforcement effect appears larger for the treatment applied on unaged foams, even if the uptake values measured are greater for aged samples.

The use of the solvent (HMDS) alone does not affect the compression properties of the foams, neither for aged nor for unaged samples which confirms that the resistance to compression is strictly related to the AMDES polymer. It is worth noting that treating an aged sample with a 10% AMDES solution in HMDS confers a resistance to compression around 6 kPa. This value is higher than that of the untreated aged sample (around 3.5 kPa) and not too far from that of the initial value (around 9 kPa) giving hope about the restoration of the initial foam strength.

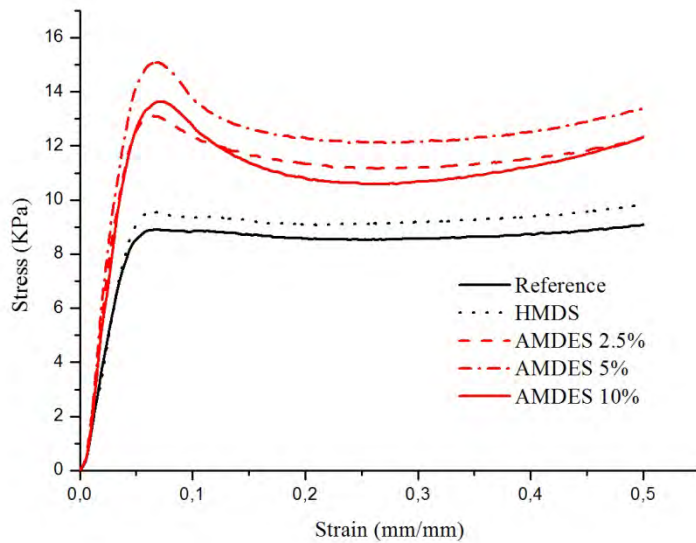


Figure 3. Compression stress/strain curves of unaged samples

Table 2. Stress values for a strain of 0.1, 0.2, 0.3, 0.4 and 0.5 mm/mm. Each value is reported as the mean value of the two specimen tested.

	0.1 mm/mm	0.2 mm/mm	0.3 mm/mm	0.4 mm/mm	0.5 mm/mm
<b>Reference</b>	8.86 ± 0.38	8.56 ± 0.33	8.56 ± 0.42	8.71 ± 0.44	9.12 ± 0.43
<b>Reference aged</b>	4.07 ± 0.28	3.56 ± 0.19	3.59 ± 0.21	3.67 ± 0.22	3.81 ± 0.21
<b>HMDS</b>	9.33 ± 0.5	9.08 ± 0.64	9.20 ± 0.69	9.39 ± 0.75	9.85 ± 0.89
<b>HMDS aged</b>	3.90 ± 0.42	3.43 ± 0.36	3.41 ± 0.33	3.55 ± 0.30	3.78 ± 0.36
<b>AMDES 2.5%</b>	12.28 ± 0.16	11.32 ± 0.19	11.22 ± 0.22	11.53 ± 0.16	12.34 ± 0.39
<b>AMDES 2.5% aged</b>	4.57 ± 0.31	4.20 ± 0.28	4.24 ± 0.33	4.33 ± 0.47	4.60 ± 0.08
<b>AMDES 5%</b>	13.65 ± 0.94	12.26 ± 0.58	12.16 ± 0.61	12.51 ± 0.66	13.45 ± 0.72
<b>AMDES 5% aged</b>	5.02 ± 0.05	4.39 ± 0.05	4.39 ± 0.00	4.57 ± 0.03	4.96 ± 0.08
<b>AMDES 10%</b>	12.61 ± 1.03	10.75 ± 0.83	10.69 ± 0.97	11.24 ± 1.03	12.36 ± 1.16
<b>AMDES 10% aged</b>	5.51 ± 0.19	5.02 ± 0.11	5.04 ± 0.19	5.37 ± 0.16	5.83 ± 0.25

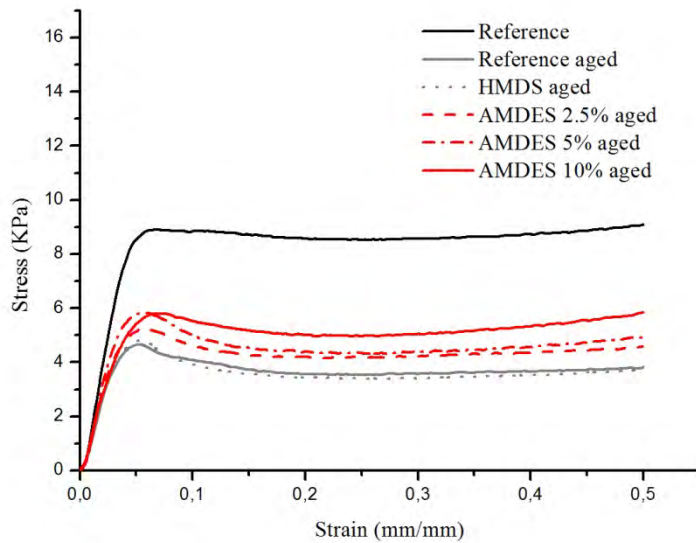


Figure 4. Compression stress/strain curves of aged samples

### SEM imaging

The sample images recorded after compression by the SEM allow for observation of the AMDES's interaction with the foam surfaces and the investigation of reinforcement effect at microscopic scale. Backscattered electron images allowed the deposits after treatment to be highlighted on the foam structure. Figure 5 shows the images of all the samples of this study (magnification x100). The unaged reference sample, flexible and elastic, keeps its structure intact after compression while, after artificial ageing, cell wall breaking occurs and the material loses its recovery properties. In Figure 5 it is shown that AMDES treatment inhibits cell wall breaking during compression and permits the recovering of the original structure when the load is removed.

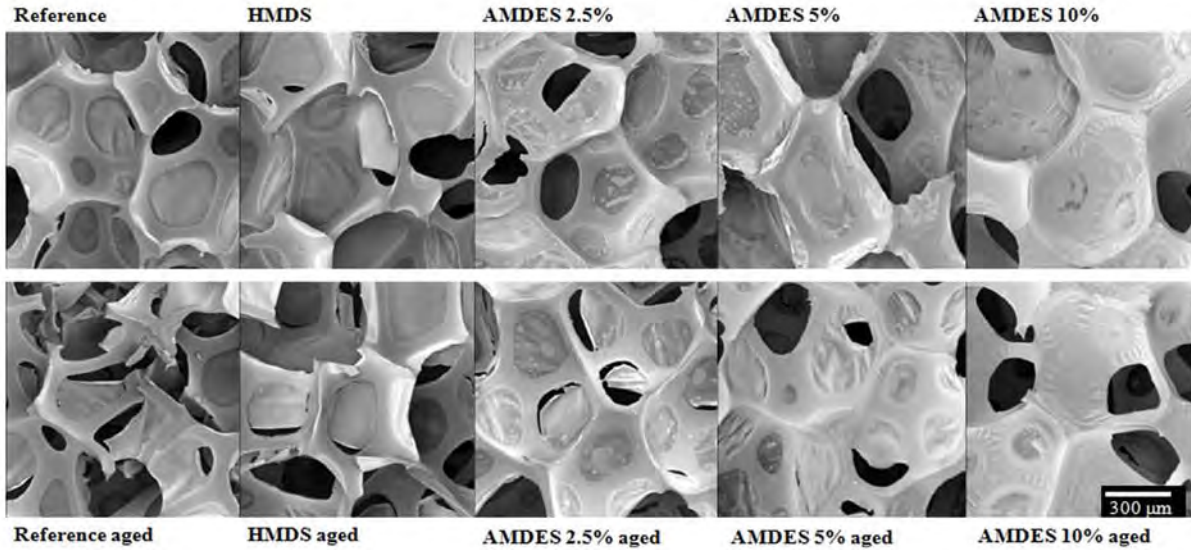


Figure 5. SEM backscattered electron images. Surface of foam samples after compression

The images also show that AMDES treatment leaves deposits on cell wall surfaces, and that those deposits are more pronounced with the increasing of AMDES concentration in HMDS. AMDES deposits are limited to the surfaces and they do not fill the void of the open cells, which is important in terms of conserving the natural structure of the foam.

### FTIR spectroscopy

To form an overall idea of the distribution of AMDES in the thickness of the samples and therefore verify the homogeneity of the treatment ATR-FTIR analyses were employed.

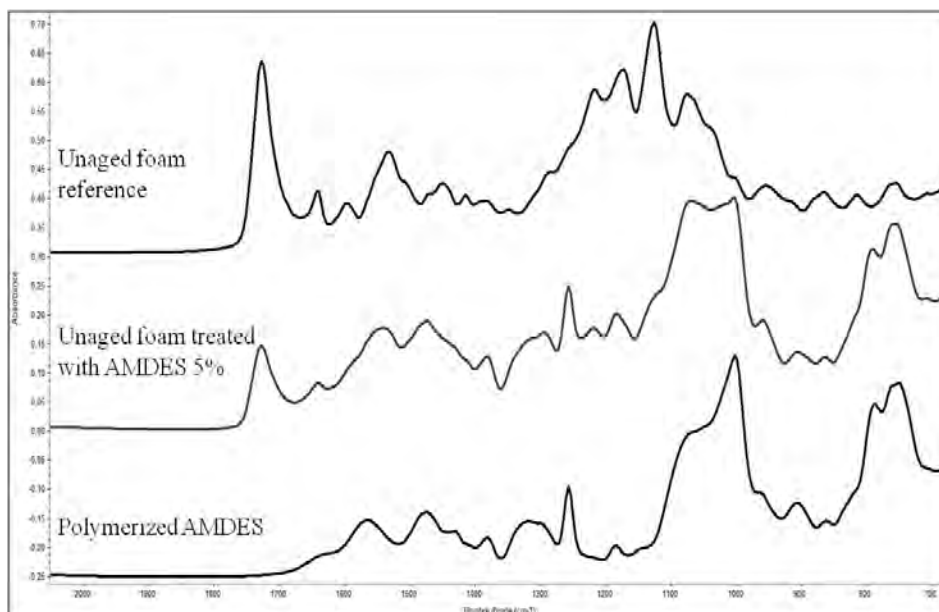


Figure 6. ATR-FTIR spectra of unaged foam, unaged foam treated with AMDES 5% and pure polymerized AMDES

On treated sample infrared spectra (Figure 6), the following polymerized AMDES infrared absorption bands have been assigned based on the literature (Coates 2000):  $1257\text{ cm}^{-1}$  (Si-CH<sub>3</sub> symmetric stretching),  $1003\text{ cm}^{-1}$  (Si-O-Si stretching),  $791\text{ cm}^{-1}$  (Si-C stretching and CH<sub>3</sub> rocking) and  $755\text{ cm}^{-1}$  (-(CH<sub>2</sub>)<sub>3</sub>- rocking). Si-O-Si absorption band at  $1003\text{ cm}^{-1}$  confirms polymerization of AMDES monomers on the foam surfaces. As shown by SEM images, the treatment forms a sort of coating on the cell walls; consequently the ATR-FTIR response of the treated foam mainly originates from the external polymer network. For this reason, on treated foam spectrum almost all infrared absorption bands, due to PUR, are hidden by AMDES absorptions and only C=O ester stretching at  $1727\text{ cm}^{-1}$  is still visible.

To obtain information about the homogeneity of the treatment, treated samples were cut in slices allowing infrared analysis to different points of the sample thickness. Five spectra were collected from each sample; two from the external surfaces and three from the bulk. In Figure 7 and Figure 8 the AMDES relative quantification, expressed by the ratio of Si-O-Si absorption band at  $1003\text{ cm}^{-1}$  to the C=O ester absorption band at  $1727\text{ cm}^{-1}$ , is plotted as a function of the depth of the points analyzed. This ratio is an indicator of the AMDES concentration. According to uptake values on unaged foams, AMDES seems to be evenly distributed (Figure 7); the differences between the values can be attributed to the experimental error. On the contrary, Figure 8 highlights a non-homogeneous distribution of AMDES network for aged samples; AMDES concentration is higher near the external surfaces of the sample and lower in the center of the foam block. The reason for this difference of concentration is not completely clear at the moment. However the results suggest that it could be attributed to a non homogeneous ageing, since treated unaged foams show even distributions in the whole thickness. According to this hypothesis, if the foam block external surface has higher concentration of degradation products than the core, AMDES polymer concentration will be higher near the surface because of its higher affinity to hydrogen bonding with carboxyl groups. Moreover, the results show that on aged sample foams higher concentration of AMDES are observed at each analysis depth point, along with uptake values.

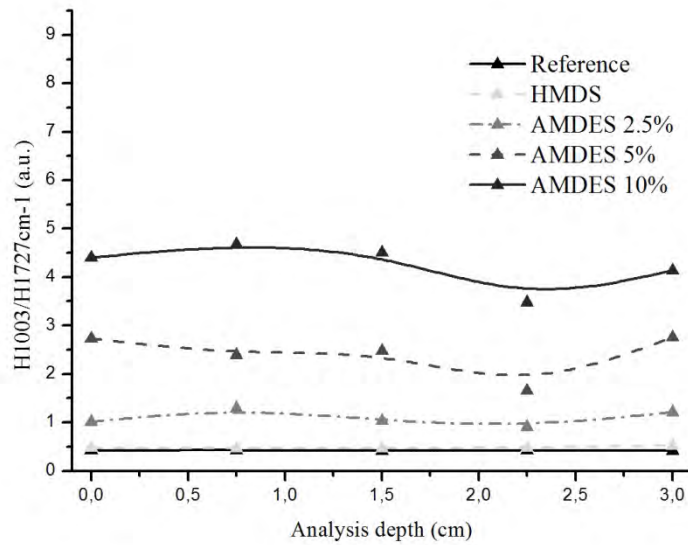


Figure 7. Unaged sample AMDES relative quantification (ratio of AMDES Si-O-Si absorption band to PU ester C=O absorption band) plotted as a function of the depth of analysis (thickness of the sample).

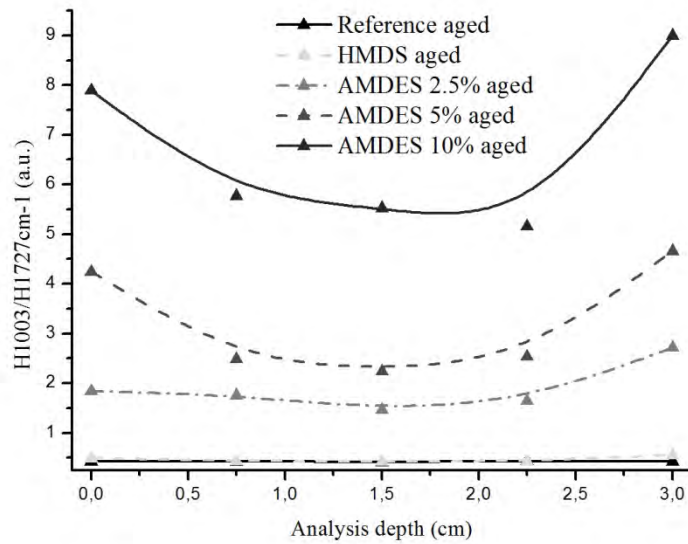


Figure 8. Aged sample AMDES relative quantification (ratio of AMDES Si-O-Si absorption band to PU ester C=O absorption band) plotted as a function of the depth of analysis (thickness of the sample).

## **Conclusion**

This study shows that, after treatment of aged and unaged PUR ester foams, a reinforcement effect is obtained. This effect is a consequence of the formation of a macromolecular network due to AMDES polymerization on the cell wall surfaces.

It was shown that after treatment the deposits formed are larger for aged samples than unaged samples. These data allow an interpretation of the interaction between the polymer network and the PUR foam surfaces: larger uptakes for aged samples are due to AMDES higher affinity to react with carboxyl groups, which are a result of the thermal degradation processes. Beyond its reinforcement effect, the polymeric network formed after treatment has two significant characteristics. Firstly, it weakly affects the visual aspect of the object since it does not change significantly its original colour when applied on unaged PUR foam and it reduces the colour degradation when applied on aged samples, secondly it does not fill the void of the open cells preserving the natural structure of the foam.

These promising results suggest that the AMDES treatment could be an efficient solution for consolidation of polyurethane ester foams. The ongoing research is geared to well establish the interaction between AMDES and PUR ester foam and to examine the ageing behaviour of treated samples.

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## **Materials and Suppliers**

Polyurethane ester foam CS-0009  
New Dimension Industries LLC (NDI LLC)  
One State Street, Moonachie, NJ 07074-1402

3-Aminopropylmethyldiethoxysilane and hexamethyldisiloxane from ABCR GmbH & Co.  
Supplied by Roth Sochiel EURL  
3, Rue de la Chapelle, F-67630 Lauterbourg

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**Eleonora Pellizzi** has a Master's degree in Science and Technology for Cultural Heritage from the University of Turin (Italy). From September 2008 to September 2009, she carried out postgraduate work (through a grant from the Fondazione Cassa di Risparmio di Torino) on the degradation of paper by iron gall ink at the Centre de Recherche sur la Conservation des Collections (CRCC) in Paris. In October 2009, she began work on a PhD (co-directed by the CRCC and the Université d'Evry-Val-d'Essonne) that focuses on the degradation and conservation of polyurethane ester foams used in works of art. This research is part of POPART, a research project (funded by the European Commission) for the preservation of plastic artifacts in museum collections.

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**Agnès Lattuati-Derieux** obtained a PhD in Organic Chemistry and Spectrometric Analyses from the University of Paris VI in 1998. From 1999 to 2001, she worked as a conservation scientist at the Institut National du Patrimoine in Saint-Denis, where she was in charge of the Organic Analyses section. This work dealt with the determination of natural substances sampled from different works of art by chromatographic techniques. She became a conservation scientist at the Centre de Recherche sur la Conservation des Collections in Paris in 2002, and currently heads the Organic Analysis and Conservation Material section. She has been involved in both national and international projects, including POPART, a research project (funded by the European Commission) for the preservation of plastic artifacts in museum collections. Her recent research includes molecular characterization of volatile organic compounds from exhibition and conservation materials, aged books, as well as archaeological and natural substances.

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**Agnès Lattuati-Derieux** a obtenu un doctorat en chimie organique et en analyse spectrométrique à l'Université Paris VI en 1998. De 1999 à 2001, elle a travaillé comme scientifique en conservation à l'Institut national du patrimoine de Saint-Denis, où elle était responsable de la section des analyses organiques. Ce travail portait sur l'analyse d'échantillons de substances naturelles provenant de différentes œuvres d'art à l'aide de techniques chromatographiques. Elle est devenue scientifique en conservation au Centre de recherche sur la conservation des collections de Paris en 2002, et dirige actuellement la section des analyses organiques et des matériaux de conservation. Elle participe à des projets nationaux et internationaux, notamment POP'ART, un projet de recherche (financé par la Commission européenne) portant sur la préservation des œuvres en matière plastique dans les musées. Ses recherches récentes s'intéressent entre autres aux caractéristiques moléculaires des composés organiques volatils qu'on trouve dans les expositions et les matériaux de conservation, aux livres anciens, aux objets archéologiques et aux substances naturelles.

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