Fire safety and inkjet printed wallcovering materials

Bruno Fouquet, Diatechnologies SAS, Châteauroux, France, and Patrick Le Galudec, Sihl, Bern, Switzerland

Abstract

The session is a follow-up of 2014 presentation on development of fire-retardant wallcoverings.

The initial research had indicated that printing with water-based and eco-solvent inks of different types had no measurable impact on the fire-retardancy properties of media. Risks identified were associated with new styles of wallpaper installations and a certain confusion resulting from the multiplicity of measuring methods and fire retardancy standards.

Mr. Fouquet and his team explored ways to deliver a compliant media meeting at the same time the visual and haptic expectations of designers and artists.

A multi-layer treatment (frontside) and the impregnation of paper backside are added to enhance the fire-retardancy performance. Another parameter to consider is a reduction of the paper weight. This may has some impact on the aesthetic and is thus to be handled with care.

With wallcovering shifting to digital on-demand manufacturing, questions on installation safety and compliance with fire regulations have to be reconsidered.

Sihl advocate the impregnation of front-side and back-side of wallpapers in order to provide users with an increased safety level without compromise on the aesthetic value.

It is a balancing act. We hope that industry will share our concerns and join us with safer and healthier products for the greater benefit of users.

Daring digital designs and new installations

Distributors of designer wallpaper report concerns expressed by clients about installation and desinstallation. When apartments or mansions are rented, it is critical to ensure that wallpaper can be removed without damaging the pre-existing paint or base-wallpaper previously put in place by the landlord.

This has led to the development of dual-sided tape installation, whereas dual-sided sticky tape is applied on to the wall. Under such installation procedure, air can circulate between the wall and the wallpaper. This could generate greater fire hazard than conventional gluing, whereas the backside of the wallpaper becomes airtight.

The risk of confusing fire-retardant and fire-resistant is also on the rise. What is obvious for trained architects becomes complicated for artists, designers and DIY enthusiasts, especially when literature on standard and performance is obscure or confusing (case of France with two older standards sharing same M1 name).

First attempt: researching a universal solution

Mr. Fouquet and is team started prototyping a development that would combine compliance with older popular domestic fire-retardancy standards "M1" – both for wallpaper glued on the wall and for wallpaper taped on the wall – and with modern Euroclass B, s1-d0.

Development started with a light 85 gsm non-woven base, to minimize amount of material to be treated. The non-woven was impregnated with a powder type fire-retardant agent (ammonium polyphosphate) on the frontside and on the backside. An inkjet receptive layer containing a lower proportion of ammonium polyphosphate was also added.

Hand-coated prototypes proved promising – no combustion at all, so that we consider for a while that we might even apply for higher A2 level. Functional testing confirmed that impregnation did not interact with conventional glues used for wallpaper installation.

However, the addition of ammonium polyphosphate did interact with water-based inks, resulting into lower image quality. Further testing confirmed that fire retardant agent hydrolysed itself, generating a greasy surface film and proving thus inappropriate for wallpaper usage, whereas stains have to be removed with a wet sponge.

This was a dead-end: it would no longer burn, but had turned into a rather poor wall-covering material.

Second attempt: enhancing existing commercial product

Faced with pressing commercial demand, Mr. Fouquet's team tried to develop a version of their preexisting "Persomural" commercial inkjet wallpaper to just achieve Euroclass B, s1-d0 and former French "M1" for glued wallpaper.

They applied on the front-side of a 150 gsm non-woven paper base:

- Precoat consisting chiefly of ammonium polyphosphate fire retardant powder
- Protective topcoat to limit the interactions between inkjet inks and the powder

This proved to be a working solution with former French "M1" standard – as flame self-extinguished with powder agent forming a wall between flame and flammable material BUT it is no longer enough with Euroclass as it includes now a "FIGRA" warming-up measurement.

> **11.6 Class B requirement**
> The product must fulfill all of the following criteria:
> a) EN ISO 11925-2
> When attacked by surface flame, or side flame with 30sec exposure time, there must be no flame propagation beyond a 150 nm distance from flame application point, this within the 60 sec. following flame application time.
> b) EN 13823
> No propagation of lateral flame (*LFS*) on the test tube side.
> *FIGRA* (= *FIGRA*0,2 MJ) ≤ 120 W/s
> *THR*600s ≤ 7,5 MJ

The opinion of measurement laboratory experts was that topcoat formulation degraded performance. So we tried a variation with a modified topcoat including up to 40% of a fire-retarding

formulation based upon organic phosphorous & nitrogen liquid compound.
This proved easy to coat, contributing to good imaging, but did not perform better under FIGRA 0,2MJ.

It did kill the flame almost immediately, but it failed to meet Euroclass B demand!

		LNE test result with fire retardant precoat & untreated topcoat		LNE test result with fire retardant precoat & fire retardant treated topcoat	
		Test n°1	Test n°2	Test n°1	Test n°2
Figra 0,2MJ	W/s	171.8	162.9	208.7	168.7
Figra 0,4MJ	W/s	83.5	67.4	146.3	130.3
THR600	MJ	1.6	1.0	1.6	1.4
SMOGRA	m²/s²	25.7	6.6	0.0	0.0
SPR600	m²	171.9	45.3	35.8	34.6

Variations up to 30% between two different testing may occur due to the nature of the experiment confirmed in practice by laboratory.
Further experiments confirmed that FIGRA test compliance would require having less material to protect. This contradicts marketing demand for a thick and relatively heavy and opaque material delivering a good working surface for designers.

Third attempt: experiments and future development directions

Following previous attempts, our researchers tried to define the maximum quantity of organic material that would be compatible with FIGRA and the reasons behind previous results.
The addition of multiple layers of fire-retardant agents should have resulted into a performance enhancement.
But, as the FIGRA test is conducted with an open flame exposition lasting 21 minutes, the warming-up of the media is directly correlated to the organic material weight involved.

		Test result with fire retardant precoat & untreated topcoat		Test results with fire retardant precoat & fire retardant topcoat		Commercial product 3260 rated C,s1-d0	Euroclass B requirement
		Test n°1	Test n°2	Test n°1	Test n°2	Average 3_measures	
Figra 0,2MJ	W/s	171.8	162.9	208.7	168.7	150	**< 120 W/s**
Figra 0,4MJ	W/s	83.5	67.4	146.3	130.3	127	-
THR600	MJ	1.6	1.0	1.6	1.4	1,9	< 7,5 MJ
SMOGRA	m²/s²	25.7	6.6	0.0	0.0	0	
TSP600	m²	171.9	45.3	35.8	34.6	31	

Organic material included into dried coating g/m²	12,1	16,85	11,5
Inorganic material included into dried coating g/m²	17,8	21,05	13,5

Compliance with Figra implies thus a reduction of mass of organic components, easiest way being the selection of a lighter non-woven base (120 gsm or less), with opacity corrected by mat pigment deposition.
Diatechnologies is currently finalizing in agreement with marketing two propositions:
A more conventional fire-retardant inkjet printable wallpaper with:

- 120 gsm non-woven base
- Frontside and backside treated with a powder based fire retardant agent
- Complemented with fire-retardant treated topcoat

A product presenting the highest level of fire retardancy with:

- Lightest non-woven base available – 85 gsm
- Opacity layer with TIO2 pigment deposition
- Frontside and backside treated with a powder based fire retardant agent
- Complemented with fire-retardant treated topcoat

The second product would provide extra safety – much more time to evacuate in case of a fire, effective fire protection in case of non-conventional installations and compliance with national standards.

Conclusion: a conflict of aesthetics, old and new standards

Sihl believes that standards should provide consumers easy access to safety. Fire hazard remains nowadays a serious risk, especially with fragile populations presenting mobility limitations. We noticed that it took time for experts to navigate between easily confusing standards and norms and that intention or initial purpose of the regulator is often lost to consumer.
We have decided to apply fire-retardant treatment on the front-side and on the backside of future products in order to provide an additional level of safety for all of the different types of wallpaper installations.
Compliance with Euroclass demanding levels will be ensured through a reduction of organic compound weight, compensated if needed by pigment deposition. We will try as much as possible to ensure compatibility with previous methods, in order to help professionals familiar with older standards to select appropriate level of fire protection for their projects.
Fireproof wallcovering demand will be address through the selection of other materials such as glassfiber.

References

[1] Euroclass reference http://virtual.vtt.fi/virtual/innofirewood/stateoftheart/database/euroclass/euroclass.html.
[2] M1 standards (in French) – LNE Database service
[3] Fire rating standards EN13501 and EN 15102+A1

Authors Biographies

Bruno Fouquet graduated from Chemical engineer school in France, worked for ink and paper makers before joining Diatechnologies 12 years ago. He is now Director of R&D for this affiliate of Sihl-Diatec group.

Patrick Le Galudec graduated from « Hautes études Commerciales » Paris, France in 1982, worked as marketing manager for Bull Periphériques, then Nipson on high speed printing machines.). He lives now in Switzerland and works on inkjet media OEM development and Asia-Pacific developments for Sihl, the Coating Company.