

# News

Performance Additives – Building & Construction Newsletter

Issue 5 November 2015

AkzoNobel 



# Content



## Content

Welcome	2
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## Product focus

ELOTEX® SEAL712	3 - 4
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## Scientific article

Kinetics of ternary flooring mortars	5 - 7
--------------------------------------	-------

## News

Dow Jones Sustainability Index	8
Responsible Care Award	8

## Events & Community activity

Conferences & Exhibitions	9
Community Event	9

Cover image:  
Rijksmuseum Amsterdam, where AkzoNobel sponsored the renovation of the museum; Picture also lately used in our Human Cities Folder.

# Welcome



Frank Grootnibbelink  
Global Business Director  
Building & Construction

## Finishing the year 2015

Dear Customers,

Welcome to our latest newsletter, the third this year, all of which we hope have helped to keep you updated on our latest news and innovations.

This year has been marked by a significant step in our innovation efforts and by launch of several unique new products. Introduction of our first to market formaldehyde free redispersible polymer powders ELOTEX® FL2200 and ELOTEX® FL2280 has drawn great market interest and we witness significant use of these grades in the demanding segment of self-levelling flooring compounds. In the tiling segment, ELOTEX® FX6300 and Bermocoll® MT 500 have enjoyed a smooth ride after the launch at the European Coatings Show – both products are already helping our customer improve open time and wet adhesion properties of the finished tile adhesives. New developments for 2016 are in the working and in the coming year you will see more new innovative solutions for the Building and Construction market coming your way.

Recently, AkzoNobel retained its no.1 ranking in the Dow Jones Sustainability Index for the fourth consecutive year. Plus, our work with product stewardship has been recognized with the 2015 European Responsible Care Award from the European Chemicals Industry Association (CEFIC). For 2016 we will further strengthen the Sustainability contribution as a pillar of our business and you will start seeing new initiatives aimed at the Building and Construction market at the beginning of spring.

Consequently, for this issue of our Newsletter, we have chosen to showcase the strength of our innovation and its link with Sustainability. We inform you on a fundamental study on kinetics of ternary flooring mortars and present ELOTEX® SEAL712, specialty hydrophobizing additive for dry mortars based on gypsum, one of the most sustainable binders in the Building and Construction industry.

As the year draws to a close, I would like to thank you for your continued support and active, mutually beneficial cooperation in making 2015 a successful year.

Frank Grootnibbelink

# Product Focus

## ELOTEX® SEAL712

highly efficient hydrophobizing and water repellent additive

Naturally occurring gypsum is one of the most versatile and sustainable building materials (due to its very low CO<sub>2</sub> footprint). However, gypsum is also formed in industry as a by-product of power stations, the fertilizer industry and in detergent manufacture. In addition to having a low CO<sub>2</sub> footprint, gypsum is infinitely recyclable (albeit some energy is used to process and transport it). Additionally, thanks to its versatility, gypsum based materials allow architects, building owners and decorators to design attractive features for modern interiors and in the process earn credits or points towards achieving a higher Green Building Rating.

One of the main deterrents to more widespread use of gypsum in building materials has been its sensitivity to moisture which causes the structure of the gypsum to deteriorate. In contact with moisture or water Gypsum is partly dissolved and can recrystallize after drying. These mass transport processes result in a significant strength reduction and surface damage.

It is well known that the water resistance of gypsum based building materials can be increased by addition of silanes, however not every silane-based hydrophobizing additive is effective in combination with gypsum. To be effective silane additives have to have a balance of properties not always inherent in this type of chemistry, and have to avoid the draw-

backs of common silane types used for hydrophobizing. To achieve high performance, the silanes employed must not adversely affect wetting of the dry mix mortar; foaming of the mortar has to be avoided, and retardation has to be eliminated. When it comes to the properties of the final hardened building material, apart from providing outstanding surface and bulk hydrophobicity, silanes must not reduce surface hardness, adhesive strength or compressive strength. All of the above mentioned points make the development of a hydrophobizing additive for gypsum a formidable task.

This challenging task was tackled by the AkzoNobel Research, Development and Innovation team [1, 2]. The team started by determining the optimum alkyl chain length of the alkyl triethoxy silanes for highest hydrophobizing effect (Figure 1) coupling that with a determination of the optimal hydrolysis time (Figure 2) of the alkyl triethoxy silanes to achieve maximum hydrophobicity. In a second stage hydrolysis products were identified using <sup>13</sup>C- and <sup>29</sup>Si-NMR techniques. Once isolated, these hydrolysis products were used in an extensive molecular dynamics simulation study to determine their interaction with gypsum crystal surfaces (illustration shown in Figure 3). With the fundamental mechanisms identified the R&D team used a carefully designed set of experiments to develop the optimal molecule for the hydrophobization of gypsum.

Result of the work is the unique **ELOTEX® SEAL712** highly efficient hydrophobizing and water repellent additive in powder form for gypsum.

**ELOTEX® SEAL712** functions chemically, protecting both the surface and the bulk of gypsum based building mortars. Moreover, **ELOTEX® SEAL712** is produced using AkzoNobel's proprietary encapsulation technology, ensuring superior wetting and mixing properties when compared to less robust competitive additives. The use of **ELOTEX® SEAL712** improves performance of key properties without any reduction of surface hardness, adhesion strength and compressive strength.

In summary, by using **ELOTEX® SEAL712**, our customers can expect the following benefits:

- Water repellency and bulk hydrophobization of gypsum products
- Increased durability of gypsum building materials
- Linear dosage efficiency
- Excellent wetting and mixing properties
- Excellent workability
- Constant product performance over time
- Long term storage stability
- Reduced need for priming before painting or wall paper coating (excellent paintability, coatability and repair)
- Free flowing and non dusting powder

### Literature

- [1] A. Winkler et al., Zement Kalk Gips, 9, 2013, 72-79
- [2] A. Winkler et al., Zement Kalk Gips, 7-8, 2013, 72-78

# Product Focus

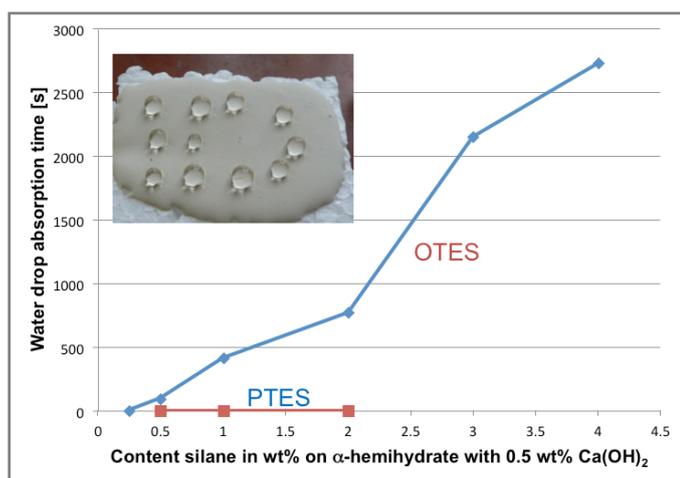


Figure 1

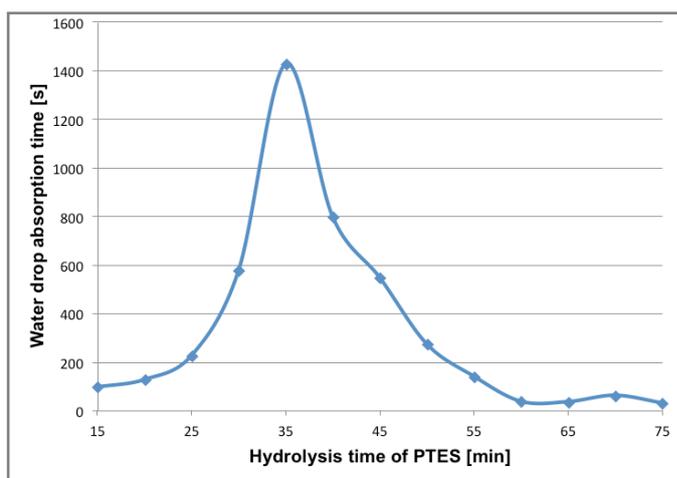
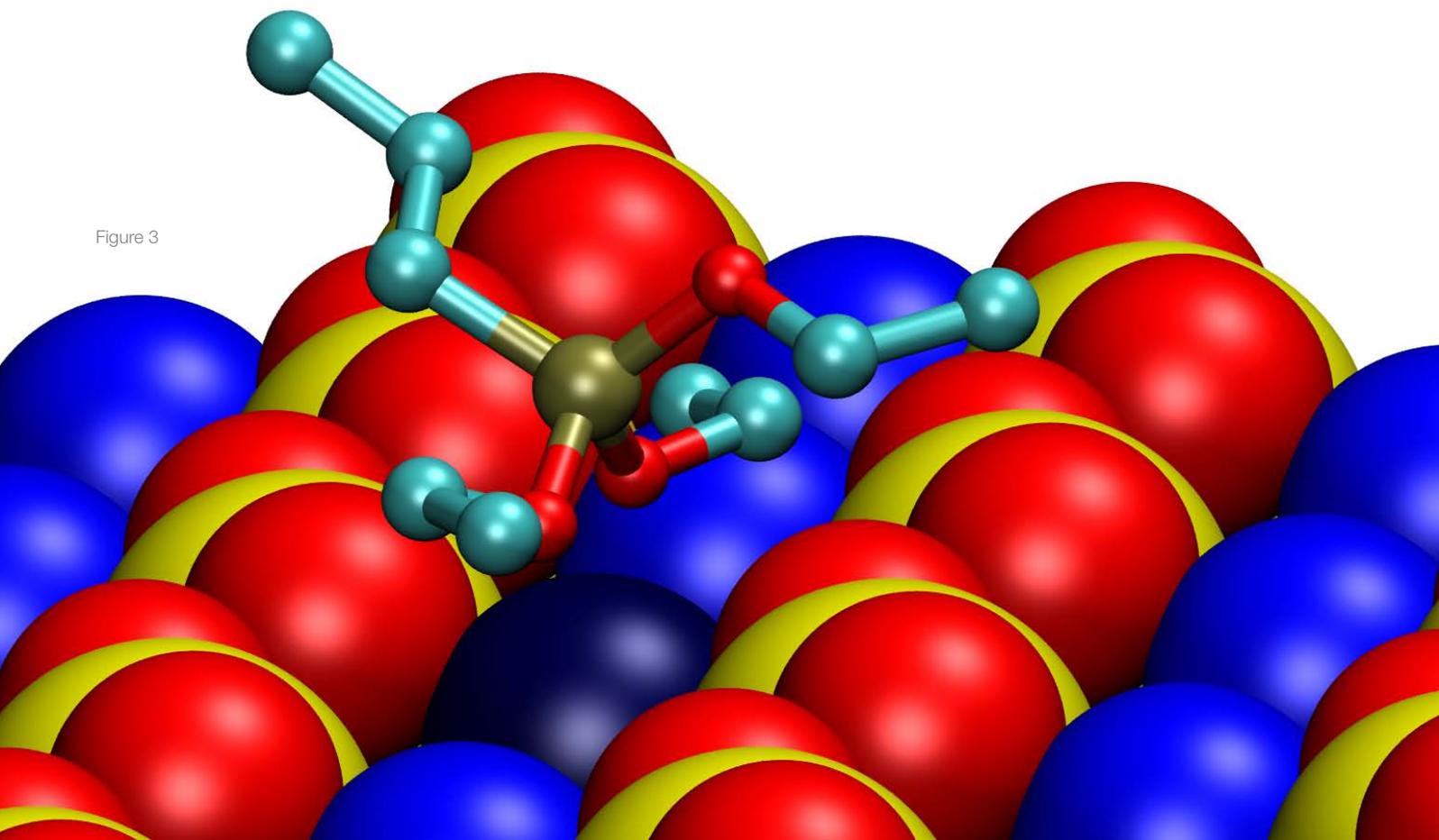


Figure 2

Figure 3



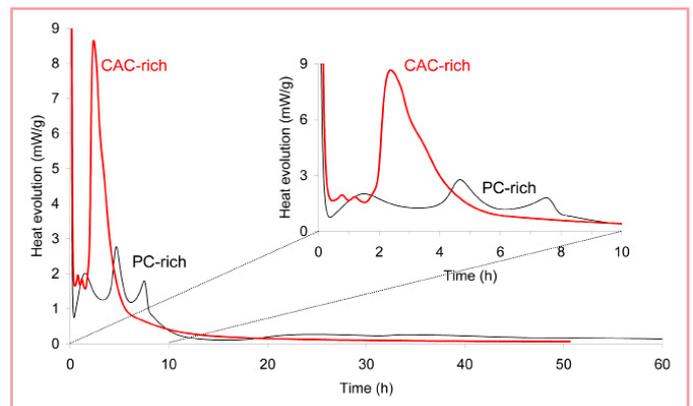
# Scientific article

## Kinetics of ternary flooring mortars

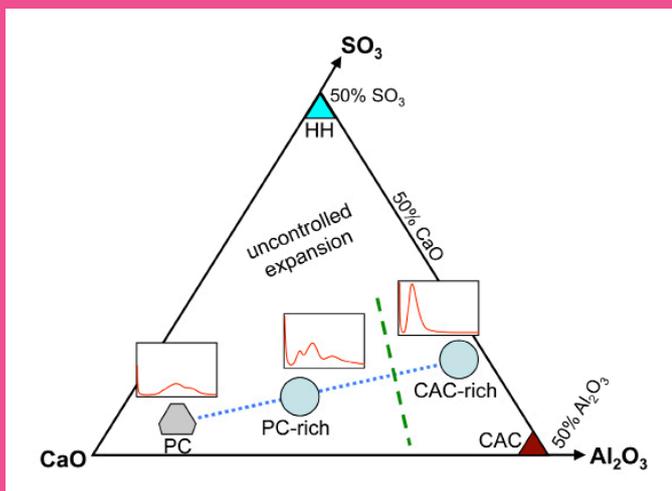
One of the main commercial requirements for mixed-binder based self-leveling compounds (SLC) is to provide a sufficiently high one-day-strength and allow for early traffic.

Hence, these SLC systems usually set and harden within half a day. Figure 1 compares the calorimetric signal of calcium aluminate cement (CAC) dominated and Portland Cement (PC) dominated formulations. The CAC-rich formulation shows a simple calorigram with one major exothermal event between 2 and 4 hours. Interestingly, the PC-rich formulation shows a complicated calorimetric pattern with several distinct exothermal events. Although several experiments with many different types of Portland cements have been made, a similar typical pattern was always found. This pattern consists of three, sometimes up to five separate exothermal signals, which are a factor of 4 less intense than the major exothermal signal of the CAC-rich formulation.

Kighelman [1] found that PC-rich formulations form secondary gypsum, which later dissolves to form further ettringite. Thus, there is evidence for several reaction stages including dissolution of primary (CA, HH) and secondary (gypsum) phases and different stages of ettringite formation. After about 20 hours (if free water is still present) calcium silicate phases begins to react.



**Figure 1:** Calorimetry of CAC-rich and PC-rich self-levelling mortars. The CAC-rich formulation shows one major intense exothermal peak (mono-episodic), whereas the PC-rich formulation shows several episodes of significantly weaker exothermal events (multi-episodic).



Kighelman [2] made measurement series where the ratio of CAC, PC and HH was systematically varied. He found that the simple mono-episodic calorimetric pattern of a CAC-rich formulation (see Figure 2) changes with an increasing amount of Portland cement, within a relatively narrow compositional field (across the dashed line in Figure 2) into a multi-episodic calorimetric pattern.

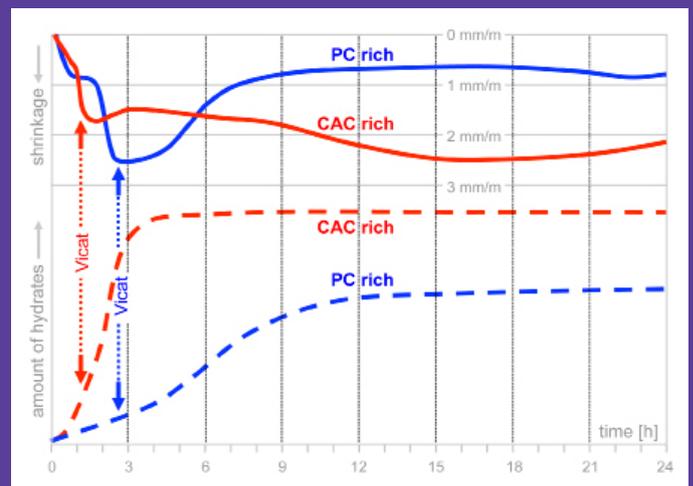
**Figure 2:** PC-rich and CAC-rich mixed binder formulations (circles) lie on a line (dotted) with a constant  $Al_2O_3 / SO_3$  ratio. The change from mono-episodic kinetics for CAC-rich formulations to poly-episodic kinetics of PC-rich formulations occurs relatively abruptly in the region of the dashed line. The three insets show typical calorimetric curves.

# Scientific article

The differences in the calorimetric signal correspond to differences in the rate of hydration and the shrinkage behaviour. Figure 3 displays the evolution of the degree of hydration (dashed curves) and the free (unrestrained) shrinkage of 4 mm thin mortar layers. Setting time was estimated for both formulations (PC-rich and CAC-rich) by the Vicat test.

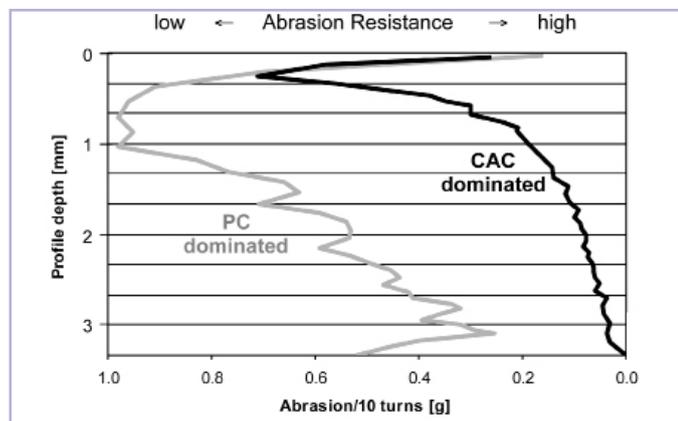
Following observations can be made:

- As soon as water is added hydrates begin to form. Thermo-gravimetric analysis reveals the formation of water-containing phases well before start of setting according to Vicat test. About 20% of the total amount of crystalline water of the finally hardened mortar is already bound in gel phases or crystalline hydrates at commencement of setting.
- During this period (plastic stage) the slurry shrinks in the order of 2 mm/m. PC-rich formulations shrink significantly more. There are two stages of plastic shrinkage. The second stage is coeval with a stiffening prior to setting (corresponding to stage 3 in Figure 4 in De Gasparo et al. [3]).
- When the slurry sets, plastic shrinkage turns abruptly into an expansion, which holds over the period of a continuously increasing degree of hydration. Interestingly, the PC-rich formulation expands much more than the CAC-rich formulation.



**Figure 3:** Free shrinkage (solid curves; Schleibinger test) and hydration kinetics (dashed curves; TGA) for PC-rich (Vicat set time: 2.6 h) and CAC-rich (Vicat set time: 1.2 h) formulations.

Apart from the endogenous reaction kinetics, given by the formulation, there are external parameters (exogenous) such as temperature and humidity, which mainly influence the drying rate of a thin mortar layer.



**Figure 4:** Abrasion profile of a PC-rich and CAC-rich hardened self-levelling compound (stored for 27 months at 23°C/50% r.h.). The measurements were done with a Taber abrasion device. After each 10 abrasion cycles the sample was weighed to estimate the amount of abraded material. These abrasion values (x-axis) are plotted against the vertical depth of the corresponding level of abrasion (y-axis). The lower the abrasion (x-value), the higher the abrasion resistance.

As expected, drying first affects the surface of the slurry followed by regions underneath it. As the drying front migrates downwards, deeper levels dry later. Thus, the deeper the location, the longer the free water is available for hydration reactions.

The downwards increasing degree of hydration is nicely portrayed by a downwards increasing abrasion resistance (Figure 4). However, the top 0.2 mm of a SLC mortar are very hard due to polymer enrichments [3]. The weak zone just underneath the hard mortar surface is due to a locally increased capillary porosity, which itself results from a reduced degree of hydration due to early drying. The diagram shows that CAC-rich formulations have an approximately five times better abrasion resistance and that the zone of weakness is significantly less weak and less thick.

# Scientific article

## Discussion and Conclusion

The multi-episodic reaction pattern of PC-rich formulations must be related (i) to different stages of increased dissolution rate (primary bassanite and secondary gypsum [1]) and (ii) to different stages of hydration, namely ettringite formation. In Figure 3 it can be recognised that the rate of ettringite formation is accelerated at about 4.5 hours. It is assumed that in PC-rich formulations the dissolution rate of sulfates and aluminates are not as well balanced as in CAC-rich formulations. Thus, ettringite forms more slowly over a

longer time span rather than in one short period like in case of CAC-rich formulations. As a result, early strength develops slower, and the risk for a reduced degree of hydration in regions near the surface is higher.

Furthermore, the multi-episodic reaction pattern marks a kinetic instability, which might be a negative factor in the context of pre-hydration (aging of dry mixes [1]) and resulting damages.

The more complicated and longer the hydration takes, the more the performance of the SLC mortar becomes dependent on external parameters such as an accelerated drying of the freshly applied mortar under dry climatic conditions. The result is a highly porous weak zone (Figure 4)

below the skin, which reduces compressive strength and scratch hardness of the hardened mortar.

The abrasion profile data of Figure 4 are a nice example how the material properties directly result from the microstructures such as the gradients in degree of hydration [1], capillary porosity and distribution of organic components [3].

Our fundamental knowledge on structure-property relationship in self-leveling compounds and our industry leading redispersible polymer powder product range for Flooring are the right combination to solve your issues in Flooring formulations. We would be glad to hear about any issue you are facing in your SLC formulations and work together towards resolving them.

## Redispersible Polymer Powders

●●● = excellent ●● = very good ● = good

Products	ELOTEX®	FL2200 	FL2211 	FL2280 	FL3210 
Technical Information	Chemical base	VA/E	VA/E	VA/E	VA/W/E
	MFFT (°C)	0	3	3	5
	VOC Emission Class	EC1 <sup>PLUS</sup>	EC1 <sup>PLUS</sup>	EC1 <sup>PLUS</sup>	EC1 <sup>PLUS</sup>
Physical Properties	Flowability	●●	●●	●●	●●●
	Surface appearance	●●	●●	●●●	●●
	Robustness in formulation	●	●	●●	●●●
	Abrasion resistance	●	●	●●	●●●
	Defoaming	-	●●●	●●●	●●
Applications	Cement based SLC with casein	●●	●●	●●	●●●
	Cement based SLC with synthetic plasticizers	●●●	●●●	●●●	●●●
	Gypsum based SLC	●●	●●	●●	●●●
	Pumpable screeds	●	●●	●●●	●●
Comments		Newly developed high quality non – defoamed RPP with extremely low VOC emissions (formaldehyde free), good leveling effects and universal properties for leveling compounds.	High quality defoamed RPP with good flow and leveling effects.	Newly developed high quality defoamed RPP with extremely low VOC emissions (formaldehyde free), excellent leveling properties and improved surface appearance.	High quality defoamed RPP providing excellent flow effects and good compatibility with other formulation ingredients.

## References

[2] J.Kighelman. Hydration and structure development of ternary binder systems as used in self-levelling compounds. PhD thesis, EPFL, Switzerland, 2007.

[1] J. Kighelman, R.Zurbruggen, K.Scrivener. Kinetics, shrinkage, microstructures and material properties of self-levelling flooring compounds: A comparison of Portland cement and Calcium Aluminate Cement dominated mixed binders. Proceedings of the idmmc one, Dry-mix Mortar Yearbook 2007, pp 68-75.

[3] A.De Gasparo, M.Herwegh and R.Zurbruggen. Mutual influence of additive fractionation and hydration kinetics in self-leveling flooring mortars. Proceedings of Calcium Aluminate Cements 2008, The Centenary Conference, Avignon, HIS BRE Press, 2008, pp 73-80.

# News

## AkzoNobel ranked top of DJSI for fourth year in a row

**AkzoNobel has been ranked number one on the influential Dow Jones Sustainability Index (DJSI) for the fourth consecutive year.**

The latest listing, published in September 2015, places our company first out of more than 350 companies in the Materials industry group. As well as underlining AkzoNobel's commitment to continuous improvement, the ranking also highlights how the DJSI can play a key role in driving innovation that benefits customers and the whole value chain.

The company has now been placed in the top three for ten years in a row and aims to generate 20 percent of its revenue from sustainable solutions by 2020. The DJSI will play an important role in achieving this, as it gives added momentum to AkzoNobel's Planet Possible sustainability strategy.

Widely regarded as the most respected independent sustainability ranking system, the DJSI World Index benchmarks the sustainability performance of leading companies based on environmental, social and economic performance, including forward-looking indicators.

It assesses various criteria, including supply chain management, operational eco-efficiency, product stewardship, human capital development and occupational health and safety.



## AkzoNobel wins Responsible Care Award for product stewardship

Our work with product stewardship has been recognized with the 2015 European Responsible Care Award from the European Chemicals Industry Association (CEFIC). Presented in Brussels, Belgium, the jury highlighted our entry for its priority substance program as: «An excellent demonstration on how to effectively engage in product stewardship».

The winning submission highlighted the work that has been taking place since 2011 to review and manage priority substances that are used in AkzoNobel's products and processes.

The program takes a proactive global approach to the management of hazardous substances used or generated in AkzoNobel products and processes and promotes the use of safer and more sustainable chemicals and substances. It also enables the company to manage harmful substances in advance of legislation.

As a Corporate wide initiative, the program is fully implemented in our Building & Construction Products Stewardship practices as we aim at reducing and eliminating the number of hazardous chemicals in our products.

# Events & Community activity

## Conferences & Exhibitions

Where the experts meet:



**ExpoMix**  
**Moscow, Russia**  
**December 1-3, 2015**  
<http://dry-mix.ru/eng>



**Paintindia**  
**Mumbai, India**  
**January 21-23, 2016**

Bombay Exhibition Center, Hall 1,  
 Booth E6A  
<http://paintindia.in/>



**World of concrete**  
**Las Vegas, USA**  
**February 2-5, 2016**

We will be presenting our annual seminar on February 3, 2016 – for further details please contact:  
[steven.grant@akzonobel.com](mailto:steven.grant@akzonobel.com)  
<http://www.worldofconcrete.com>



**MECS Middle East Coatings Show, Dubai**  
**March 14-16, 2016**

Za'abeel Halle 1, Booth B12  
<http://www.coatings-group.com/show/mecs/dubai/2016>



**AC American Coatings Show**  
**Indianapolis, USA**  
**April 12-14, 2016**

Indiana Convention Center,  
 Booth 2161  
<http://www.american-coatings-show.com/>

## Community Event

**Performance Additives provides a fresh coat of paint**



The Performance Additives team located in Brewster, NY happily presents their fresh coat of paint to the historic tunnel at Metro-North Westport Train Station in Saugatuck, Connecticut.

This tunnel was constructed in 1946 to provide business commuters traveling from Connecticut to New York with a safe place to walk to and from the train. The tunnel protects travelers from crossing a very busy street. Steve Grant, Commercial Manager, North America (right, front) is very familiar with this area, in fact Westport is his home town and he's directed traffic on that very street. Prior to AkzoNobel, Steve worked with the Westport police department and it was his existing relationship which lead us to help keep this needy tunnel looking alive and safe. Our donation of time and services went a long way for the Saugatuck / Westport Community who is currently preparing the site for an upcoming project.

This fits perfectly in our Human Cities Initiatives where we support local communities to enable people to benefit from our time and resources. Here we have kept the heritage for this historic tunnel and gave it just a bit of shine!



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[www.akzonobel.com/elotex](http://www.akzonobel.com/elotex)

AkzoNobel is a leading global paints and coatings company and a major producer of specialty chemicals. Calling on centuries of expertise, we supply industries and consumers worldwide with innovative products and sustainable technologies designed to meet the growing demands of our fast-changing planet. Headquartered in Amsterdam, the Netherlands, we have approximately 46'000 people in around 80 countries, while our portfolio includes well-known brands such as Dulux, Sikkens, International, Interpon and Eka. Consistently ranked as one of the leaders in the area of sustainability, we are committed to making life more liveable and our cities more human.

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