Coating Materials

Smart Coatings For Improving Indoor Air Quality

Formaldehyde Abatement Technology

Indoor Air Quality (IAQ): A Growing Concern

- Air pollution can cause health problems such as respiratory diseases (e.g. asthma), allergies, and possibly lung cancer
- As more and more time is spent indoors, indoor air quality (IAQ) has become one of the major health issues on the agenda of the European Commission
- Tobacco, cleaning products, fuel for cooking and heating, emission from construction materials and furniture are common sources of indoor air pollution
- **Formaldehyde is one of the substances listed by the EU as being of high concern in connection with IAQ**

Source: Dow 2020

Formaldehyde Abatement Example

Hypothesis

- 30 m^3 room, 40 m^2 of painted walls and ceiling (window and door surface areas removed).
- Satin paint example with 40% reactive PRIMAL™ SF-208 ER Binder.
- Air flow in public buildings: 18 m^3/h.

Source: Dow 2020

FORMALDEHYDE SOURCES

How Do People React When Over-Exposed to Formaldehyde?

Concentration of formaldehyde in the air:

- ~ 60 – 70 µg/m^3: children may breathe heavily
- ~ 100 µg/m^3: adults may sense a peculiar smell and feel uncomfortable
- ~ 500 µg/m^3: there may be eye irritation, causing lachrymation (excessive tearing)
- ~ 30’000 µg/m^3 (30 mg/m^3): fatal to humans

Source: Dow 2020

Regulatory Responses

Several countries have already set up standards on formaldehyde levels in ambient air in living spaces:

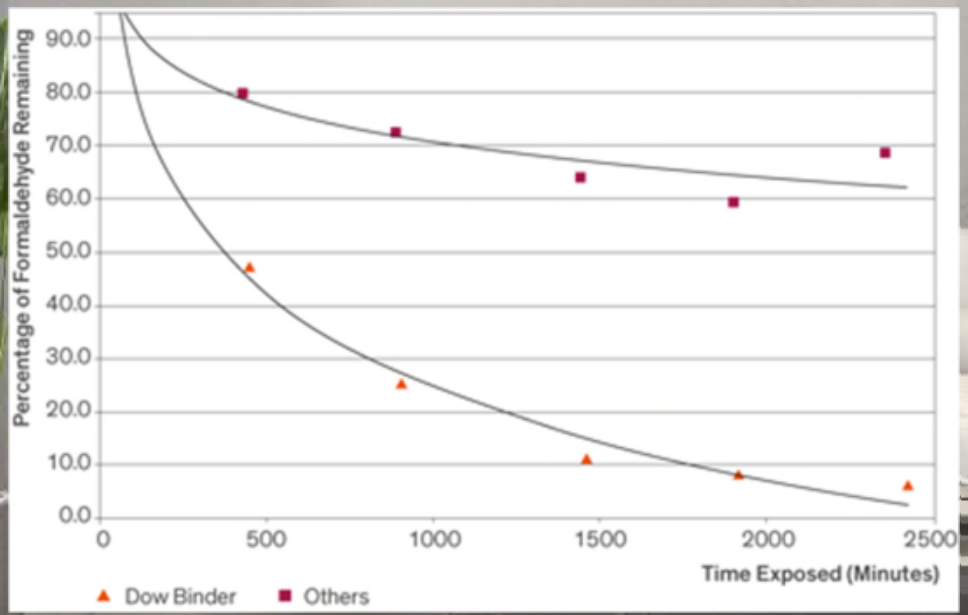
- USA 0.24 mg/m^3
- Germany 0.12 mg/m^3
- Australia 0.12 mg/m^3
- Switzerland 0.24 mg/m^3
- Singapore 0.12 mg/m^3
- Japan 0.12 mg/m^3
- China 0.08 mg/m^3

- **Regulatory developments were first initiated in China where pollution and indoor air quality topics are high concern**
- Many EU members are now taking regulatory action, as have countries around the world
- In France, for example, air quality must be monitored in public buildings, started by preschool 1st of January 2018 with recommended formaldehyde guide-value at 30 µg/m^3 and limit-value at 100 µg/m^3

Source: Dow 2020

THE DOW COATING MATERIALS RESPONSE!

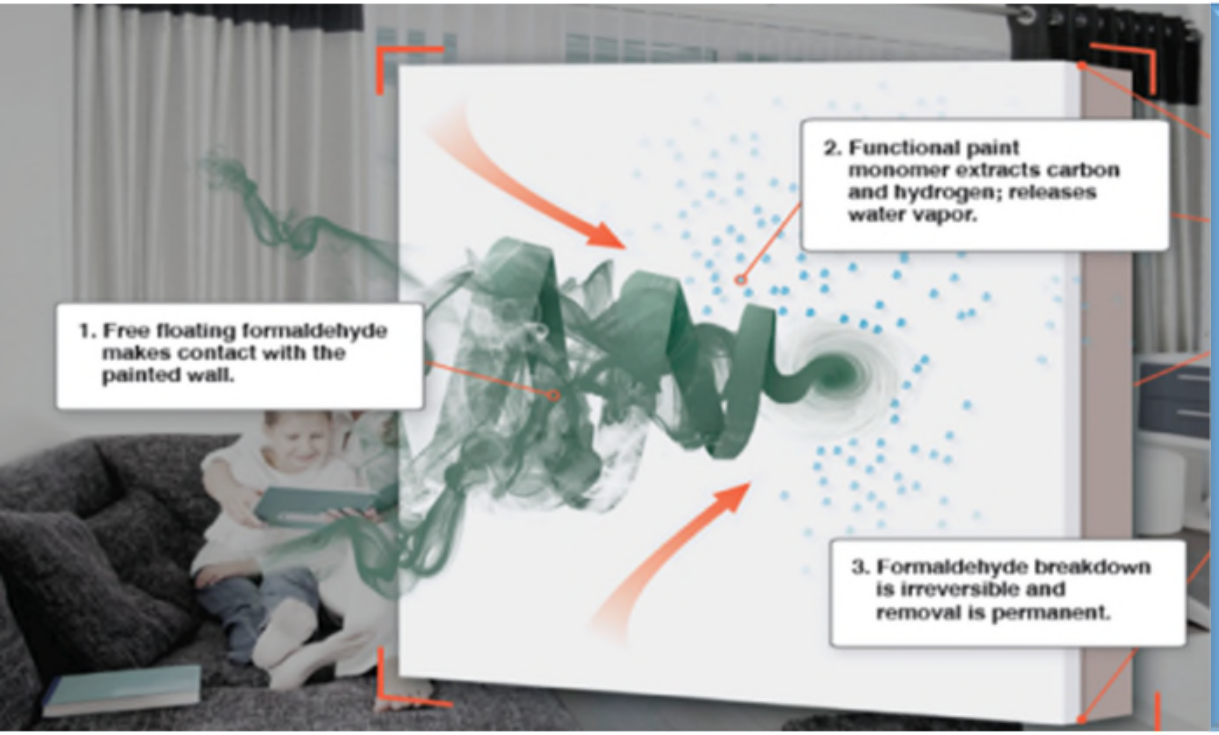
Formaldehyde abatement rate testing
Dow R&D Center – Springhouse, US



- Dow Coating Materials has developed reactive binder designed to abate formaldehyde using **FORMASHIELD™ Technology.**
- Today, all paints based on FORMASHIELD™ Technology pass the Chinese standard (GB standard +).
- A new low-odor, self film forming binder based on FORMASHIELD™ Technology is available in Europe: **PRIMAL™ SF-208 ER** Binder.
- External lab certification (Certech) confirms formaldehyde abatement
- Dow has also developed analytical techniques to measure formaldehyde reduction in a given volume.

Source: Dow 2020

ENABLING FUNCTIONAL BINDERS



FORMASHIELD™ Technology

- ✓ Removes formaldehyde from indoor air
- ✓ Converts to harmless water vapor

Source: Dow 2020

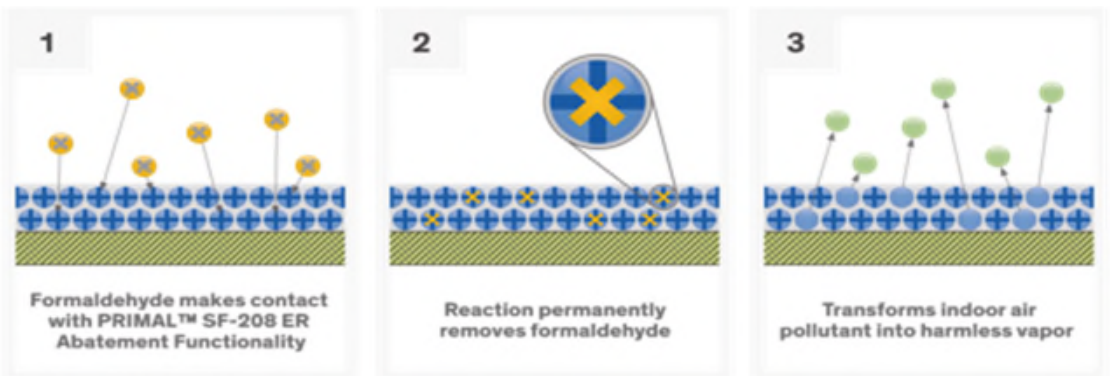
FORMALDEHYDE ABATEMENT TECHNOLGY: PRIMAL™ SF-208 ER BINDER

PRIMAL™ SF-208 ER Binder with FORMASHIELD™ Technology for Interior Wall Paints

- ✓ Formaldehyde abatement
- ✓ Acrylic co-polymer
- ✓ Self film forming
- ✓ Low odor
- ✓ Matt to satin paints
- ✓ Very good wet scrub

Paint	% Abatement	% Released
PRIMAL™ SF-208 ER	85.6	0.0
Commercial Paint	19.7	93.2
Control	0.0	100.0

How PRIMAL™ SF-208 ER Binder Works



Source: Dow 2020

FORMALDEHYDE ABATEMENT TECHNOLGY WITH

PRIMAL™ SF-208 ER Binder

Additional Features and Benefits

- ✓ APEO-free*
- ✓ No coalescing agent required for film formation (MFFT <5°C)
- ✓ Ambient cross linking technology for enhanced paint film performance
- ✓ Very good adhesion on aged alkyds
- ✓ Wide formulating window with good balance of dry film properties
- ✓ Can be formulated like any other conventional self film-forming styrene acrylic binder
- ✓ Compatible with all pigment types, extenders, dispersing agents and rheology modifiers

Source: Dow 2020

*PRIMAL™ SF-208 is APEO free, being manufactured without the use of APEO surfactants.

FORMALDEHYDE REDUCTION DETERMINATION

Dow Headspace GC-MS Test Method

Headspace unit connected to GC/MSD

Vial contains same paint surface area to volume ratio as in a typical room:

Room dimensions: 3 m x 4 m x 2.5 m
47 m^2 (walls and ceiling)
30 m^3

Paint surface area to volume ratio = 1.6 m^{-1}

Analytical Techniques

- 22ml Headspace vial containing a 0.36cm^2 paint film on aluminium
- Vial is spiked with formaldehyde
- After 48hrs, data collected over time using a GC-MS

Source: Dow 2020

PRIMAL™ SF-208 ER BINDER FOR SEMI-GLOSS PAINT

Material Name	Kilograms	Level
Grind		
Water	65.64	
OROTAN™ 731A ER	12.63	1.0% Disp
Tego Foamex 805	1.69	
ACRYSOL™ RM-5000	3.51	
Ti-Pure R-706	172.68	15.3% PVC
Minex S30	142.99	19.7% PVC
Grind Sub-total	**399.15**	
Let Down		
PRIMAL™ SF-208 ER	436.54	
ACRYSOL™ RM-5000	19.47	
ACRYSOL™ RM-8W	8.56	
Water	136.28	
Totals	**100.00**	

Source: Dow 2020

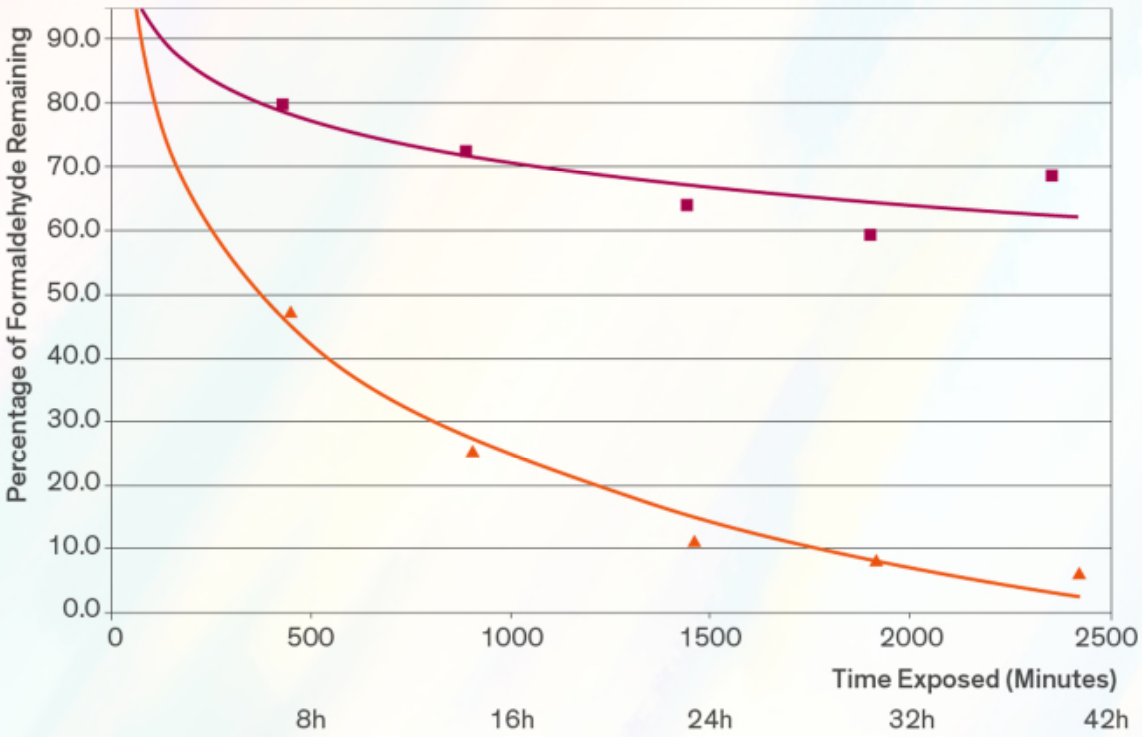
PRIMAL™ SF-208 ER BINDER FOR SEMI-GLOSS PAINT

Property	Value
Total PVC	35.00%
Volume Solids	37.30%
Weight Solids	52.30%
Density	1.3230 kg/l
Dry Density	1.8400 kg/l
Rheology at equilibrium	
Brookfield, 4/6 rpm, cps	12700
Brookfield, 4/60 rpm, cps	6570
ICI, po	1.6
KU	121
Paint characteristics	
Gloss 20°/60°/85°	2.1/12.2/18.3
Stormer viscosity, Krebs units	125
ICI cone & plate, po	1.6
Brookfield sp4, 6 rpm, cps	6000
Brookfield, sp4, 60 rpm, cps	4730

Source: Dow 2020

Formaldehyde Abatement Concept Proof For Reactive Binder

Headspace formaldehyde % remaining as a function of time (40 µm film thickness)

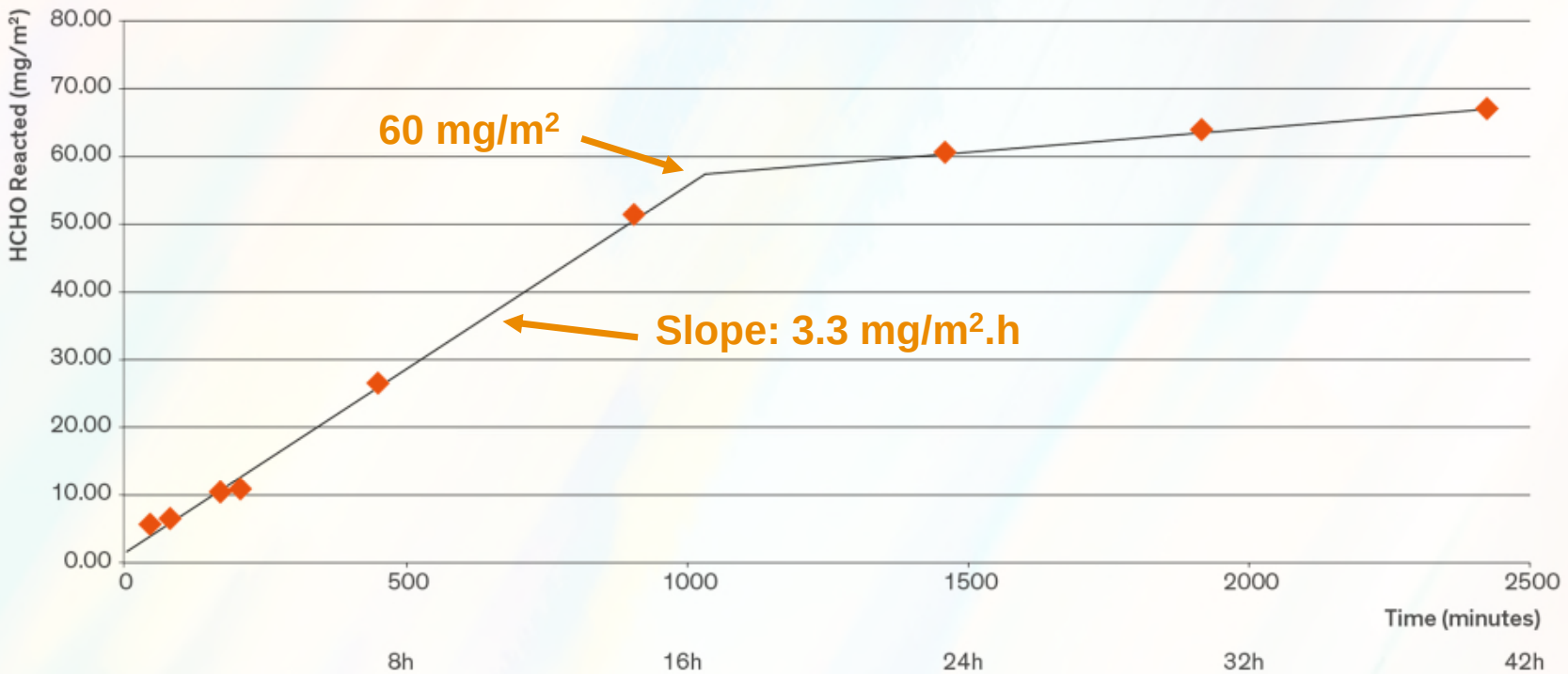


- **Non reactive (reference)**
- **Reactive binder**

Source: Dow 2020

Amount of Formadehyde Reacted as a Function of Time

(per m^2 of reactive coating)



Source: Dow 2020

Formaldehyde Abatement: Key Findings

- ✓ **PRIMAL™ SF-208 ER Binder-based paint effectively abated formaldehyde within two days.**
- ✓ **Control paint absorbed some formaldehyde, but did not reduce formaldehyde levels to detection limits.**

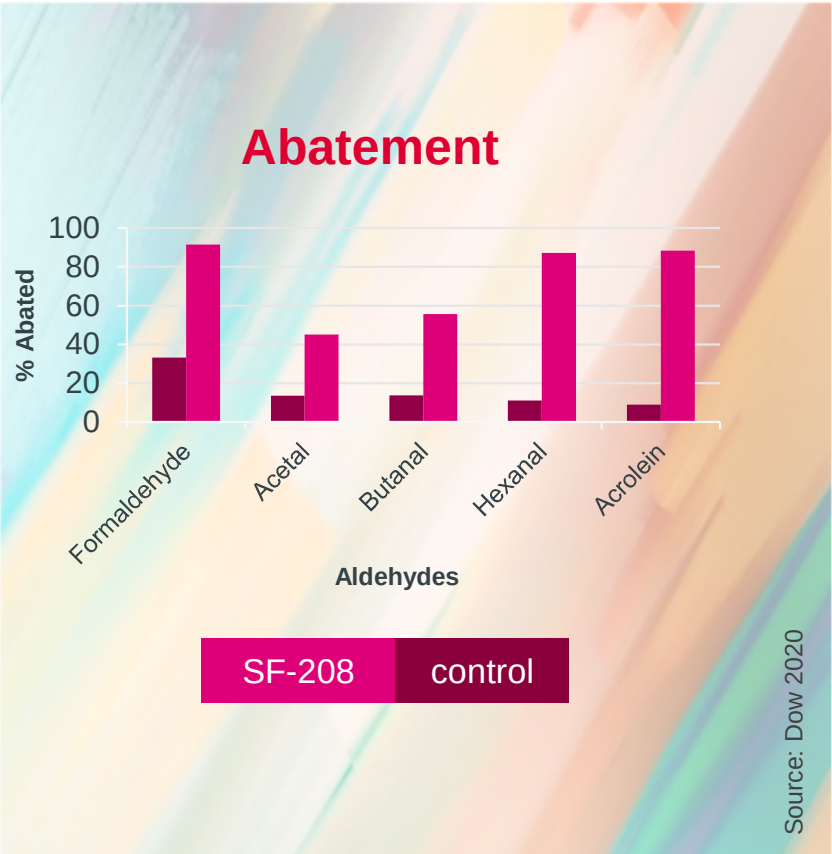
Formaldehyde abatement capacity

- ✓ Measured amounts matched theoretical values
- ✓ Satin paint with 40% by weight PRIMAL™ SF-208 ER Binder has the capacity to remove 1.08 mg formaldehyde per gram of paint
- ✓ A 40m^2 painted wall should be able to abate ~ 7 grams of formaldehyde

Reversibility

- ✓ Formaldehyde abatement absorption was shown to be irreversible
- ✓ Control paint released absorbed formaldehyde when clean air was added to the chamber

Effective on other aldehydes



FORMALDEHYDE ABATEMENT IN SATIN PAINT BASED ON

PRIMAL™ SF-208 ER Binder

Binder wet content in paint, weight %	40	
Thoretical formaldehyde abatement (g) per kg of paint	1.08	
Spreading rate, m^2/L	8	
Paint use, L/m^2	0.125	
Density kg/L	1.35	
Weight of wet paint/m^2, kg	0.17	= 0.125 x 1.35
HCHO abated per m^2 of painted surface, g	0.17	= 1.08 x 0.17

HCO conc., $\mu g/m^3$	Total HCHO in the room, µg	Theoretical HCHO abatement from painted surface in room, g	Quality of HCHO in µg/h	Expected number of years in total HCHO has reached the surface
10	300	7.3	180	18.5
15	450	7.3	270	12.3
20	600	7.3	360	9.2
30	900	7.3	540	6.2
50	1500	7.3	900	3.7
75	2250	7.3	1350	2.5
100	3000	7.3	1800	1.8

For a concentration of 30 µg/l of formaldehyde, theoretical calculations predict that the paint will remain efficient for about six years if total formaldehyde reaches the paint.

Source: Dow 2020

IMPROVING INDOOR AIR QUALITY & CREATING A HEALTHIER BUILT ENVIRONMENT WITH

PRIMAL™ SF-208 ER Binder

- ✓ There is a clear need to improve Indoor Air Quality and protect health: formaldehyde is one of the substances listed by the EU as being of high concern in connection with Indoor Air Quality.
- ✓ FORMASHIELD™ Technology has enabled development of binders such as PRIMAL™ SF-208 ER, for manufacture of interior paints capable of abating formaldehyde levels without emitting harmful substances.
- ✓ PRIMAL™ SF-208 ER Binder enables production of low odor, low VOC paints with very good film performance.
- ✓ **Dow is committed to such innovations that support more sustainable solutions without compromising on quality and performance.**

Source: Dow 2020

THANK YOU

Seek

Together™

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Source: Dow 2020

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