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3M Advanced Materials Division

The elements of what's next.

Ramspec

Milano, 12/10/2015

Anti-condensation and solar paints: which fillers

Agenda

- Interior paints
  - Introduction
  - First drop: condensation time
  - Nordtest
- Exterior paints
  - Introduction
  - What’s on the market
  - Glass Bubbles influence and formula optimization
- Conclusions

Anticondensation paints

Anticondensation paints

Why?

Anti-condensation paint is a great way to cover the walls of places like bathrooms, kitchen, basements, garages, sheds, and entry areas. Reducing some of the moisture buildup in areas of our home and increase its comfort.
Testing shows that anticondensation paints formulated with 3M glass bubbles can offer a number of benefits compared to typical standard paints:

- Reduce condensation
- Increase paint surface temperature
- Increase comfort

Effusivity and "warm touch"

- $e = \sqrt{\lambda \cdot \rho \cdot C_p}$
- $T_m = T_1 + (T_2 - T_1) \frac{e_2}{e_1 + e_2}$

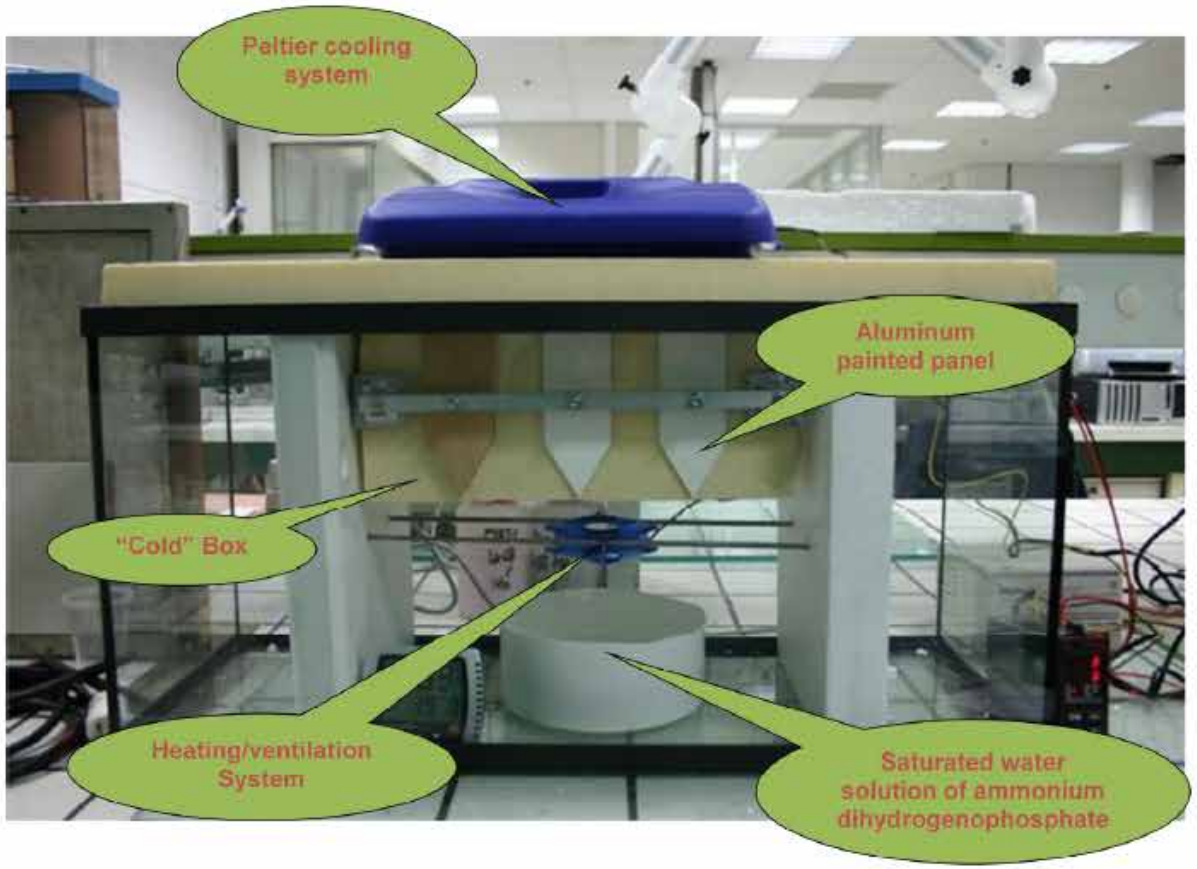
Effusivity measures the rate at wich a material can absorb heat

Study no.1

First drop: condensation time

Anticondensation paints

Condensation time



	Density g/cc	w % Solids	Vol % Solids	Condensation time (min)	
Ref. paint	1.49	56.0%	34.4%	24	
Paint A	1.11	58.0%	53.4%	20	
Paint B	1.04	54.0%	52.2%	26	
Paint C	0.98	37.0%	38.3%	29	3M GB
Paint D	0.97	52.0%	53.4%	41	3M GB
Paint E	0.9	43.0%	48.7%	44	3M GB

Test conditions:

Ambient temperature: 22°C
Dew point: 19-20°C
Cold temperature: 3°C

Test performed at 3M France

Study no.2

Nordtest: anti-condensation performance

Anti-condensation test

Nordtest NT Poly 170

This Nordtest method specifies a test method for the ability and capacity of coatings to prevent condensation from the surrounding air on the coating surface

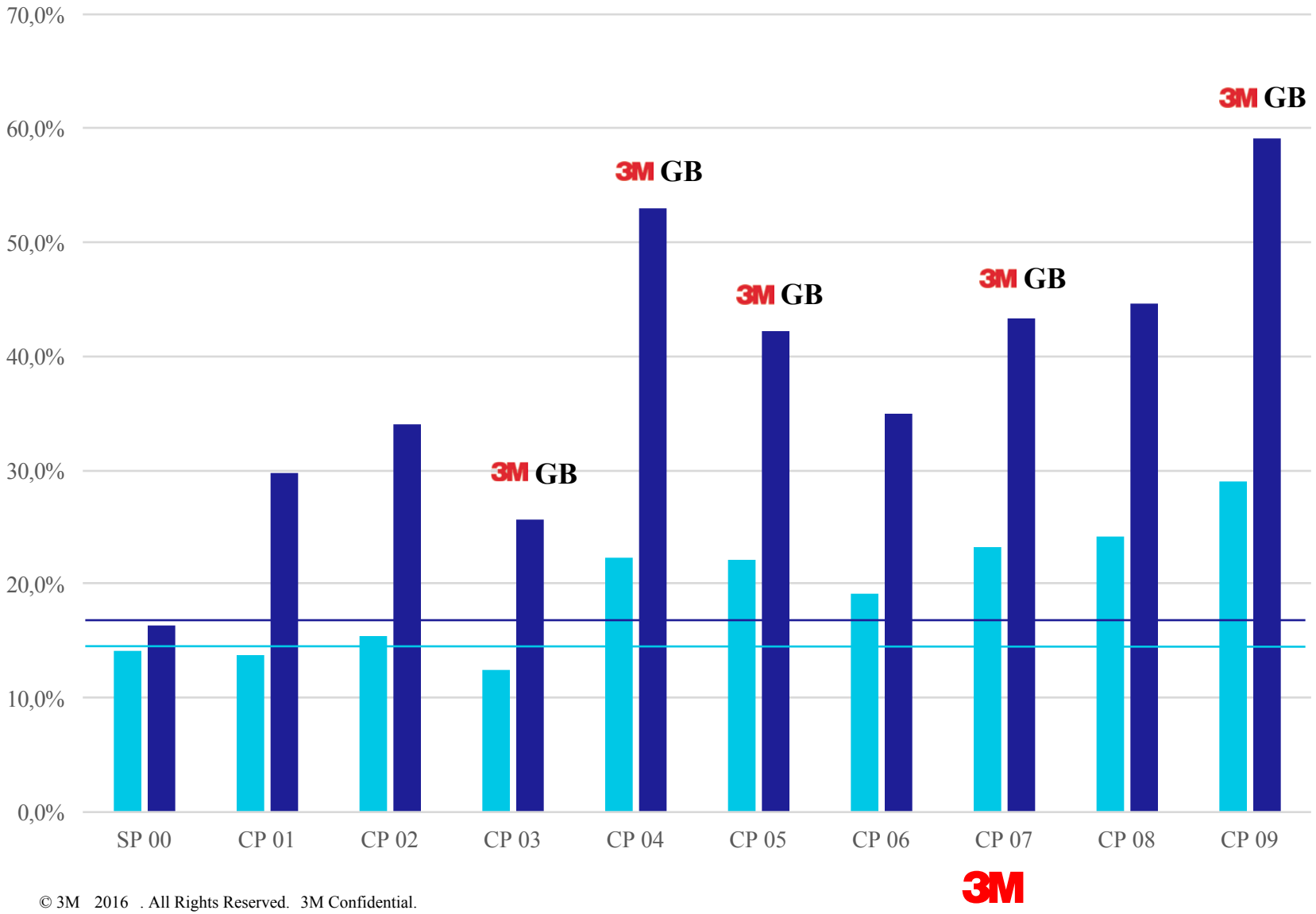
The paint coating for testing is applied to full coverage on the outside of open cylindrical stainless steel containers with conical bottom.

Following this the containers are dried until constant weight.

The containers are filled with ice and water to cool the steel and the surface to zero centigrade. They are then left in a controlled climate for water condensation until water starts to drip from the container bottom tips.

The containers are emptied of ice and water and dried on the inside by wiping with a dry cotton towel prior to determination of the weight increment during the test.

Anti-condensation paints on the market



$$\text{WPAC} = \frac{\text{WCsa - WCdp}}{\text{Wwp}} \times 100$$

$$\text{EWPAC} = \frac{\text{WCsa - WCdp}}{\text{Wdp}} \times 100$$

Wcsa: weight of container + water saturated paint
WCdp: weight of container + dry paint
Wwp: weight of wet paint applied)
Wwp: weight of dry applied)

Test performed at Salentec

Solar paints & Cool roofs

Solar Paints & cool roofs

Why?

Effective solar management – or the lack of it – can have a significant impact on cooling costs.

Testing shows that solar reflective roof coatings formulated with 3M glass bubbles can offer a number of performance and cost benefits compared to typical "cool roof" coatings.

- Higher total solar reflectance
- Lower inside temperatures
- Reduced cooling costs

Solar radiation spectrum:

- UV: 200–400 nm → 5% of sunlight energy
- Visible: 400–700 nm → 46% of sunlight energy
- Near Infrared: 700–2500 nm → 49% of sunlight energy felt as heat

Accounts for 96% of radiation in sunlight

Solar reflection

Definitions

Solar Reflection

Typical "cool roof" coatings have TSRs >80%, primarily in visible and infrared regions. (TSR) is a weighted average of solar reflectance at each solar energy wavelength.

Thermal Emittance

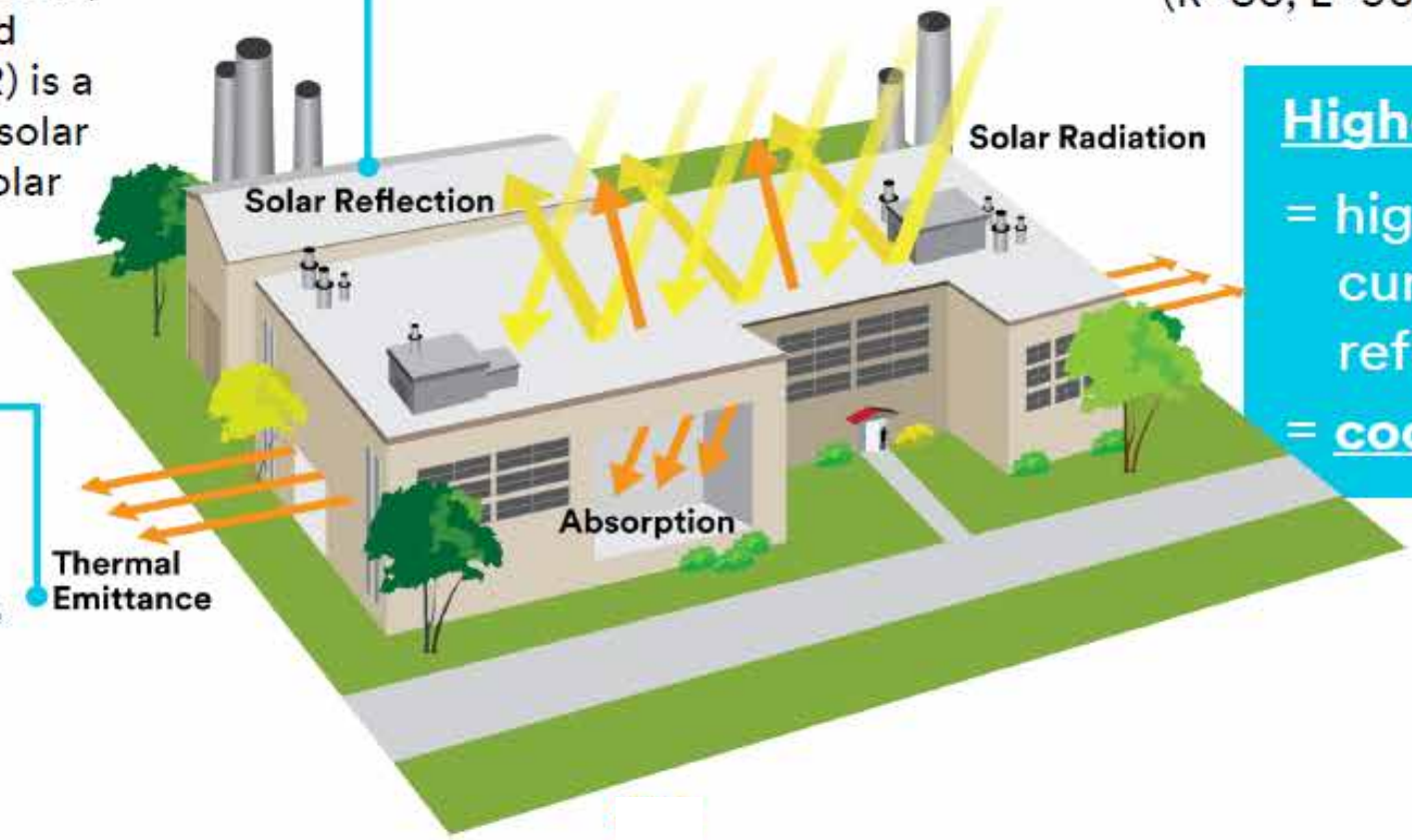
Amount of heat radiated per unit area at a given temperature (ability to give up heat).

Solar Reflectance Index (SRI)

*Calculations allow for SRIs >100.

A combined value of Reflectance and Emittance.*

- Standard black surface = 0 (R=5, E=90)
- Standard white = 100 (R=80, E=90)



Higher SRIs

= higher cumulative solar reflectance

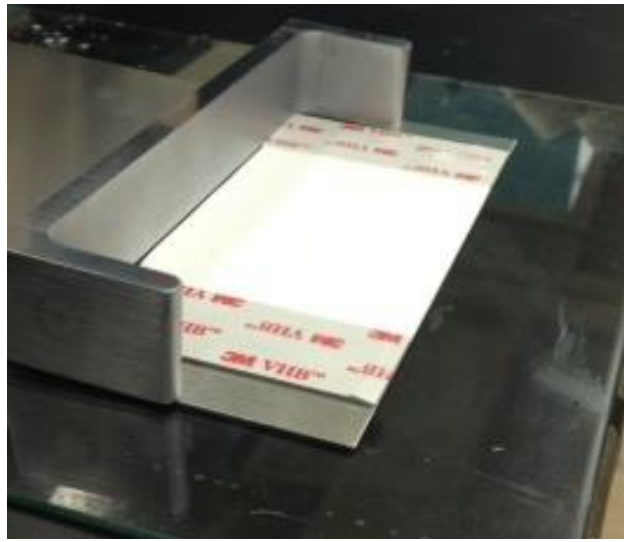
= cooler surfaces

Solar reflection

Test Method

Application
Used drawdown bars on Leneta charts & 3003 H14 aluminum

Cure
Air dry minimum 72 hours before testing

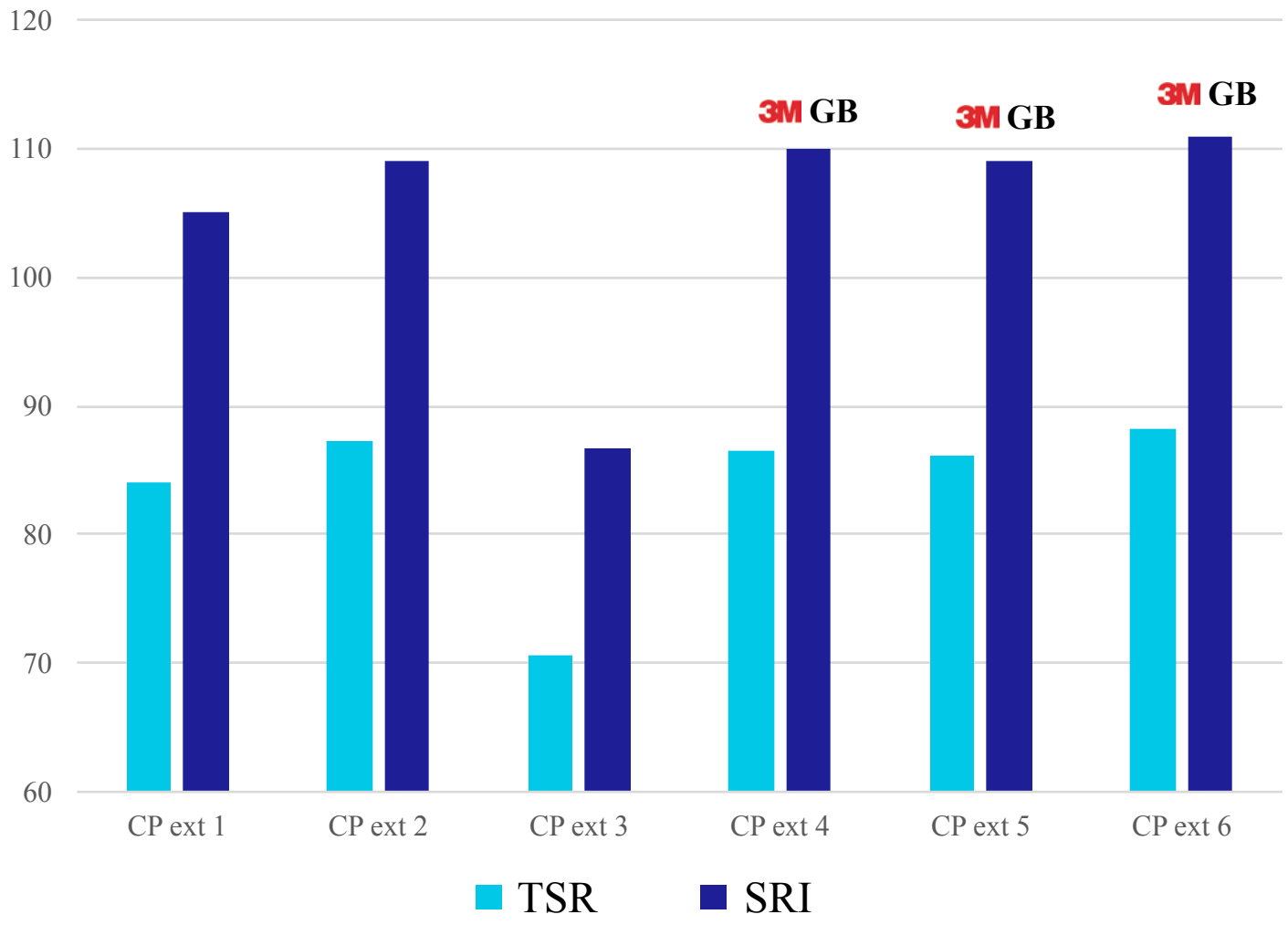


Property	Test Method
Reflectance	ASTM E1347
Dry film thickness	PosiTector 6000
Solar Reflectance	ASTM E903
Solar Reflectance Index	ASTM E1980
Thermal Emittance	ASTM C1371

Study no.1

What’s on the market?

Solar paints on the market



Paint	TSR	SRI
CP ext 1	84	105
CP ext 2	87.2	109.1
CP ext 3	70.7	86.7
CP ext 4	86.5	110
CP ext 5	86.2	109
CP ext 6	88.3	111

Test performed at Salentec

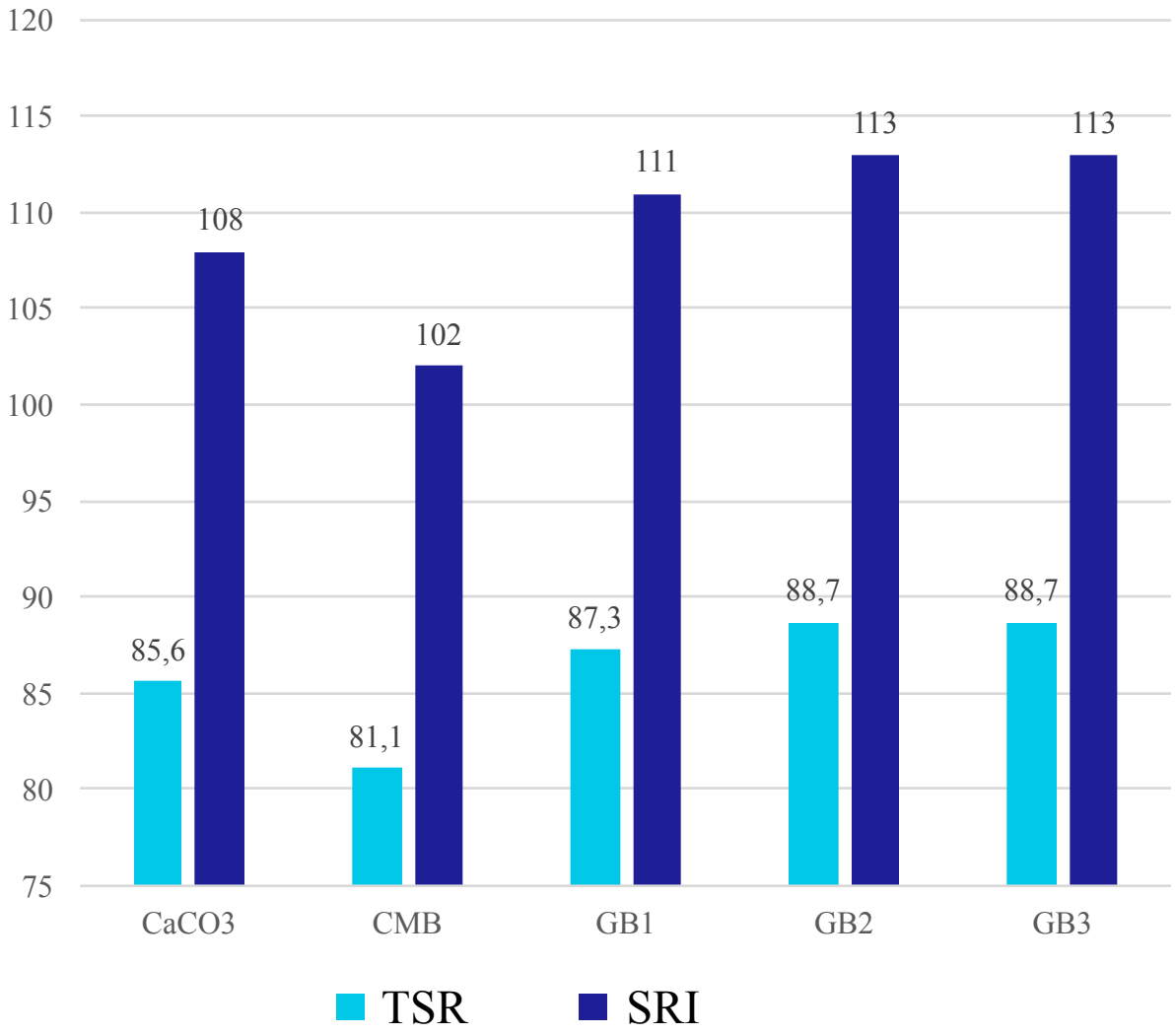
Study no.2

Glass Bubbles influence and formula optimization

Formulations

		$CaCO_3$ (control)	GB3	GB1	CMB	GB2
Material	WPG	Amount (vol %)	Amount (vol %)	Amount (vol %)	Amount (vol %)	Amount (vol %)
Water	8.34	18.23	18.23	18.23	18.23	18.23
Dispersant	10.00	0.50	0.50	0.50	0.50	0.50
Potassium Tripolyphosphate	21.15	0.07	0.07	0.07	0.07	0.07
Cellulosic Thickener	11.61	0.30	0.30	0.30	0.30	0.30
Defoamer	7.10	0.28	0.28	0.28	0.28	0.28
Microbicide	8.33	0.18	0.18	0.18	0.18	0.18
Wetting Agent	8.97	0.22	0.22	0.22	0.22	0.22
Titanium Dioxide	32.33	2.32	2.32	2.32	2.32	2.32
Zinc Oxide	46.82	0.96	0.96	0.96	0.96	0.96
Calcium Carbonate	22.70	18.72	0	0	0	0
100% Acrylic Elastomeric Binder	8.70	54.60	54.60	54.60	54.60	54.60
Defoamer	7.10	0.21	0.21	0.21	0.21	0.21
Coalescent (e.g. Texanol™)	7.91	0.76	0.76	0.76	0.76	0.76
Mildewcide	8.60	0.28	0.28	0.28	0.28	0.28
Ammonia (28%)	7.69	0.13	0.13	0.13	0.13	0.13
GB3	3.84	0	18.72	0	0	0
GB1	1.04	0	0	18.72	0	0
Commercial Microsphere Blend	6.1	0	0	0	18.72	0
GB2	1.84	0	0	0	0	18.72
Propylene Glycol	8.66	1.62	1.62	1.62	1.62	1.62
Water	8.34	0.61	0.61	0.61	0.61	0.61
TOTALS		**99.99**	**99.99**	**99.99**	**99.99**	**99.99**

Solar reflectance



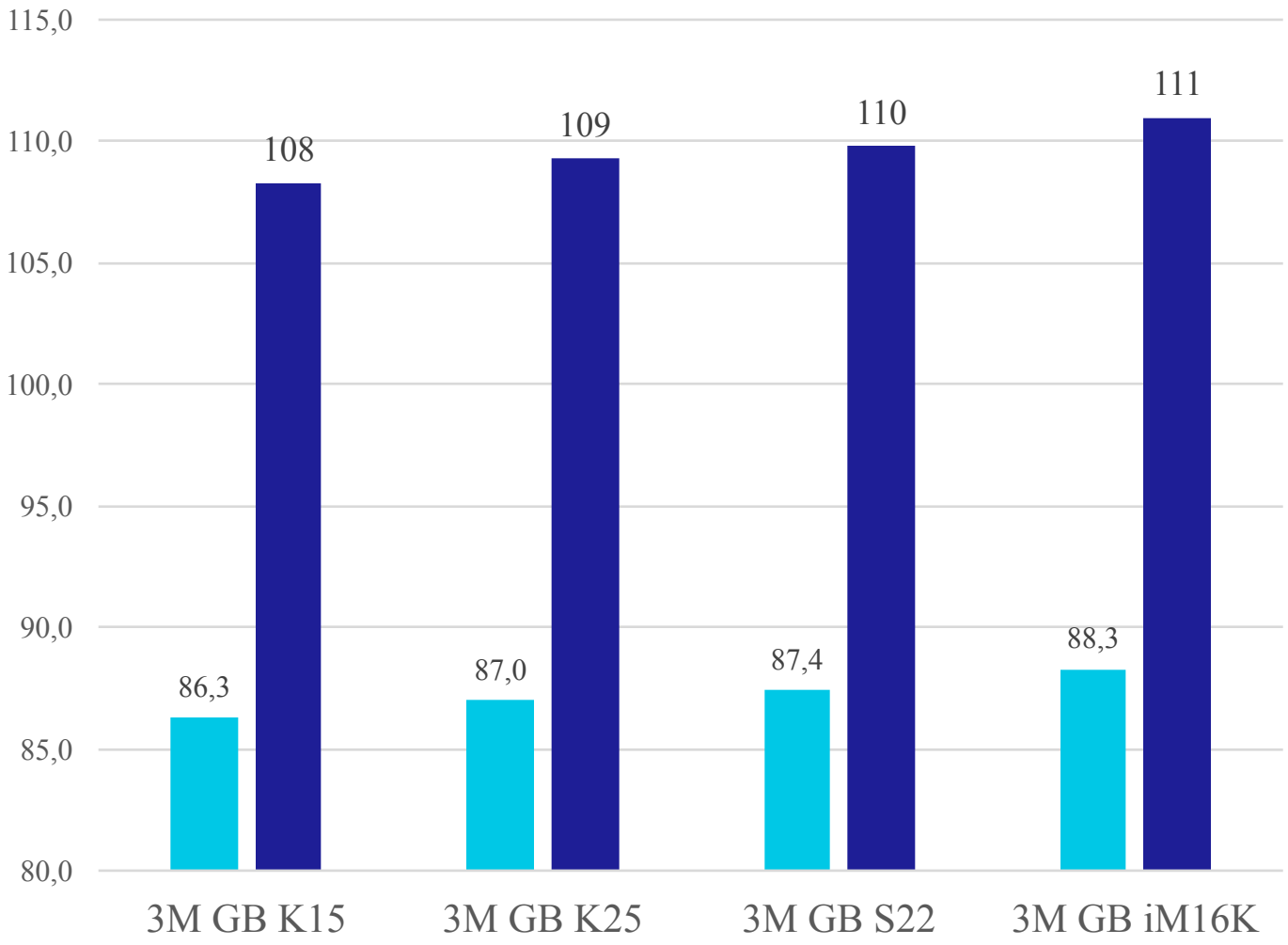
Test results

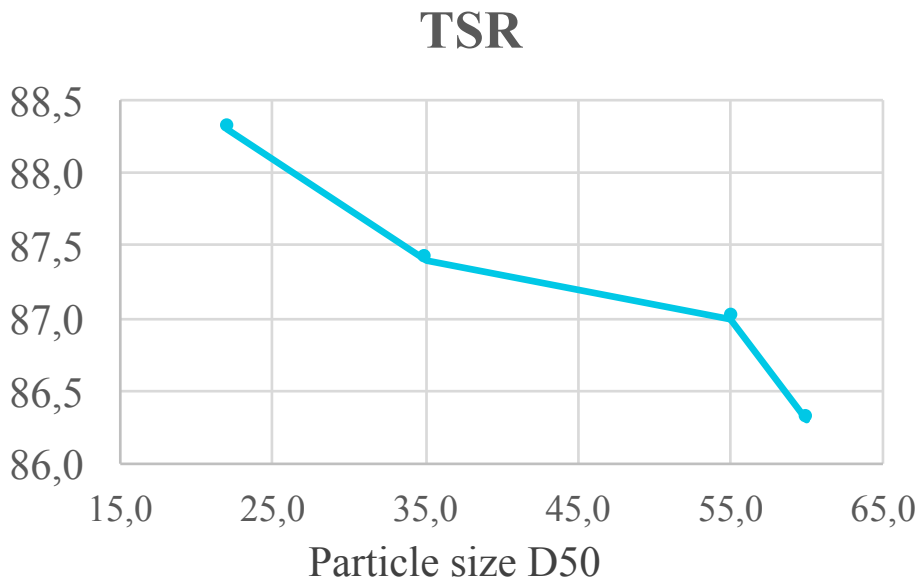
Sample	Thermal Emittance	TSR	SRI
CaCo3	0.93	85.6	108
CMB	0.92	81.1	102
GB1	0.93	87.3	111
GB2	0.91	88.7	113
GB3	0.92	88.7	113

Glass Bubbles' features

Grade	Density	Particle size Distribution (microns by volume)		
		10%	50%	90%
GB1 (K1)	0.125	30	65	115
GB2 (S22)	0.22	20	35	65
GB3 (iM16K)	0.46	12	20	30

Solar reflectance





Glass Bubbles' features

Grade	Density	Particle size Distribution (microns by volume)		
		10%	50%	90%
K15	0.125	30	65	115
K25	0.25	25	55	90
S22	0.22	20	35	65
iM16K	0.46	12	20	30

Theoretical savings

One example: http://web.ornl.gov/sci/roofs+walls/facts/CoolCalcEnergy.htm

Formulation with 18.7% Vol Loading	TSR	Emittance	Energy Cost $/kWh	Saving $/m2/y
GB 1	87.3	0.93	0.2	4.58
GB 2	88.7	0.91	0.2	4.67
GB 3	88.7	0.92	0.2	4.67

*R value	Place	Air Conditioner Efficiency	Heat	Heat Cost ($/kwH)	Heat Efficiency
10	Miami, FL	2	Electric	0.2	0.7

Many factors can affect overall savings calculations

Conclusions

Thanks to their unique features, 3M Glass Bubbles enhance coatings performance both on interior and exterior paints

Increase comfort and save energy!

Thank you