

# Performances anticorrosion des revêtements automobiles

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Les rencontres de la peinture anticorrosion  
« La préparation de surface »

Paris, 4 avril 2012



Photo PSA



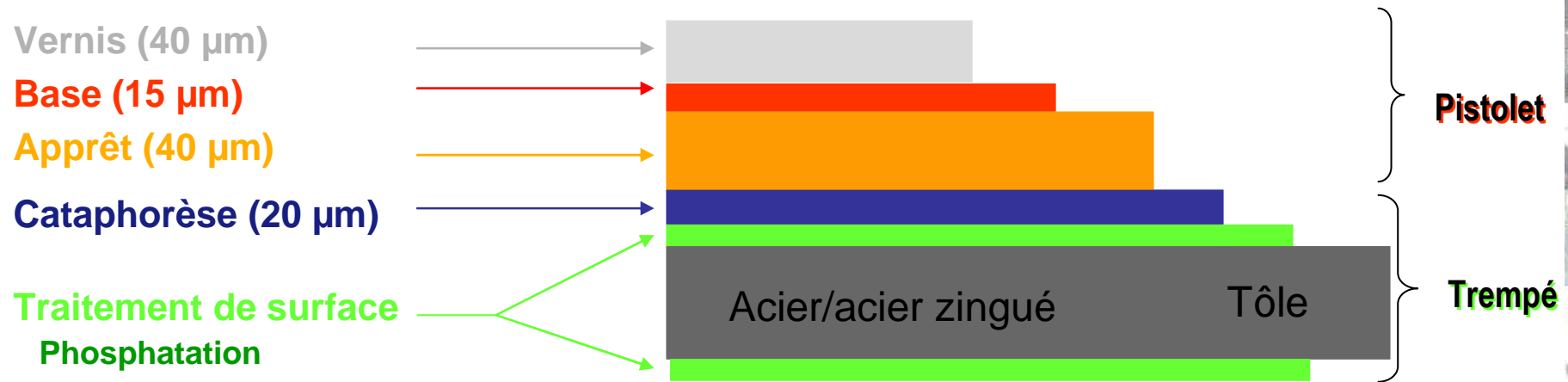
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- Introduction
- Partie expérimentale
- Résultats
- Conclusions



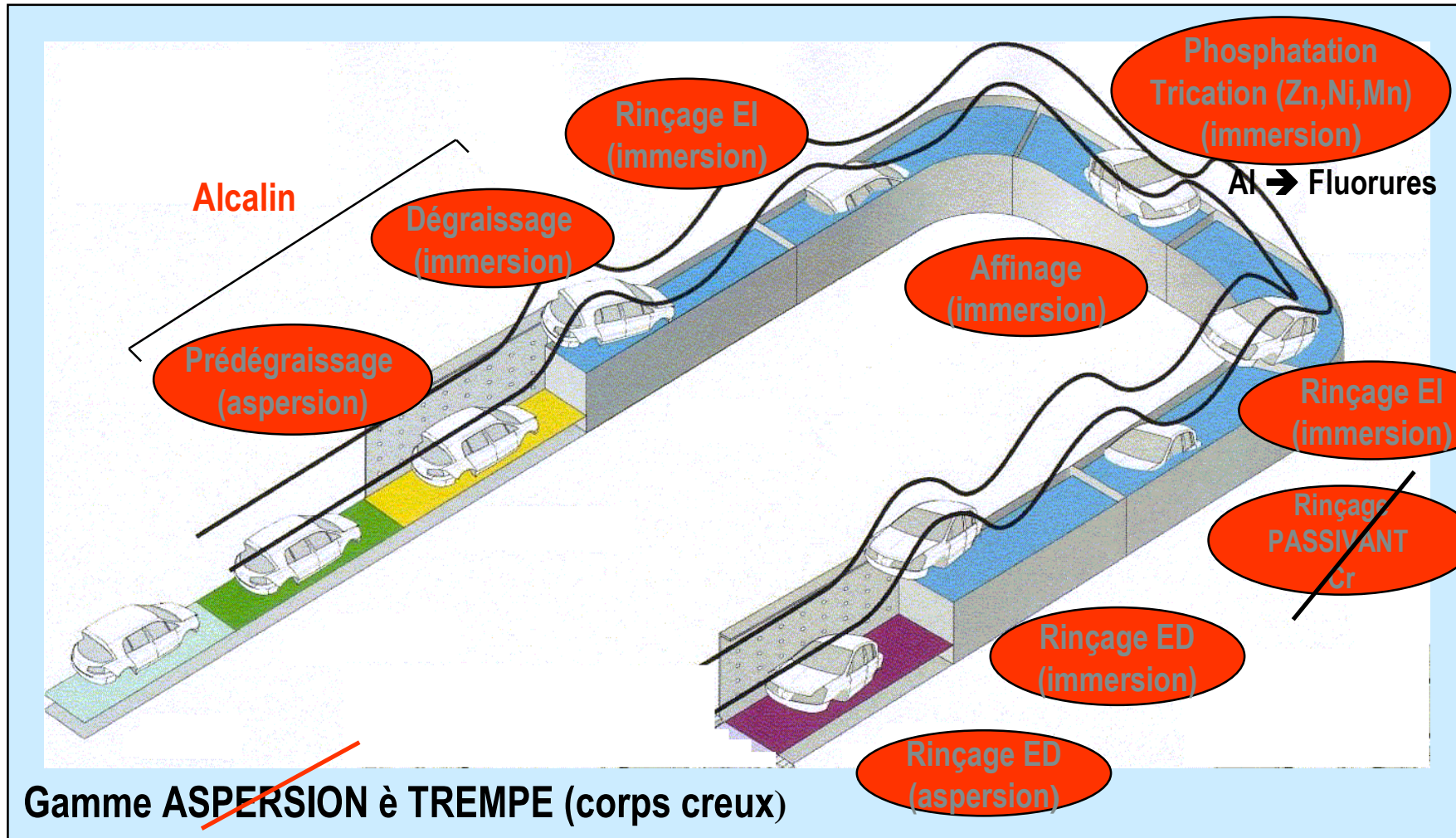
## Revêtement de peinture automobile Esthétique et protection anti-corrosion

### GAMME PEINTURE CAISSE ASSEMBLEE



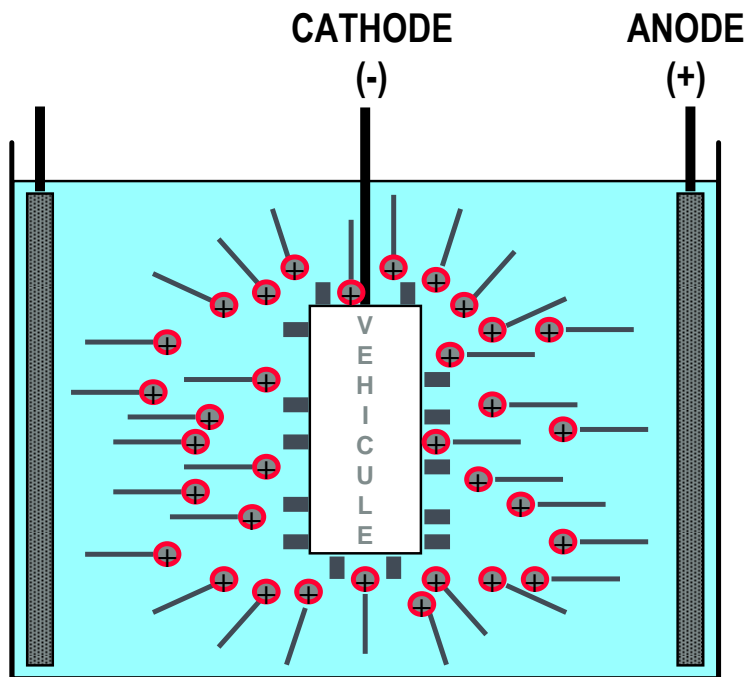
# Introduction

Introduction



from Renault

## PEINTURE CATAPHORESE – Dépôt par *ELECTROPHORESE*



Bain **AQUEUX**  
Résine **ORGANIQUE** chargée **POSITIVEMENT**  
**CHAMP ELECTRIQUE** entre anode et cathode

**DEPLACEMENT** de la résine chargée vers la **CATHODE**

**NEUTRALISATION** de la résine à la surface de la cathode

**COAGULATION** de la résine à la surface de la cathode

**RINCAGE** de l'exédent de résine non coagulée

**CUISSON** de la résine

from Renault

# Introduction

Introduction



Photos from PSA



## Comment éviter ces situations ?

- Corrosion cosmétique



- Corrosion en corps creux / zone confinée



## Optimisation des performances anticorrosion

### ➔ Tests de corrosion

Sélection de matériaux, Contrôle qualité, Traitements de surface, Validation process/nouveau produit.. etc

**Exposition sur véhicules/  
« Proving ground »**

**Tests accélérés de  
corrosion développés par  
les constructeurs auto**

Tests =

- Temperature & R.H.
- Solutions salines
- Cycle séchage/humidité
- Durée







- Les tests accélérés de corrosion ont souvent été développés sur des bases empiriques sans liens avec le terrain/mécanismes. Ex: brouillard salin
- Il existe un grand nombre de tests accélérés utilisés selon les industries → comparaison difficile des résultats
- Souvent pas ou peu de comparaisons avec le terrain

## But

**Comparison de tests accélérés utilisés par l'industrie automobile :**

- ⇒ **besoin de données: corrélation entre tests**
- ⇒ **Comparaison avec des données de terrain**

1. **Bare materials** (CRS, pure zinc and aluminium) :  
→ metal loss
2. **Cosmetic panels** of CRS, HDG and aluminium(painted) : → scribe creep



# Cosmetic panels

Experimental



Substrate	Reference	Surface treatment	Painting system
<b>CRS:</b> <b>Acier laminé à froid</b>	<b>CRS-P1</b>	Phosphating	E coat (20µm) + top coat (80 µm)
	<b>CRS-P2</b>	Phosphating	Painting system (80 µm ):E-coat / Filler / Waterborne Basecoat / Clearcoat
<b>EG</b>	<b>EG</b>	ND	Full Paint System (ND) 100µm
<b>HDG:</b> <b>Acier galvanisé à chaud (ligne)</b>	<b>HDG-7.5</b>	Phosphating	Painting system (80 µm ):E-coat / Filler / Waterborne Basecoat / Clearcoat
	<b>HDG-7</b>	Phosphating	-Powder paint 'PP' -Wet paint
	<b>HDG -9</b>	Phosphating	Painting system (100 µm ): E-coat (20 µm) / Filler (30 µm) / Metallized solvent base coat (15 µm) / Clearcoat (35 µm)
	<b>HDG-10</b>	Phosphating	E coat (20µm) + top coat (80 µm)

Painted aluminium alloys were also tested (not presented here)

2 vertical scribes 100x0.5 mm (rectangular blade Elcometer 1538)

# Accelerated Corrosion tests

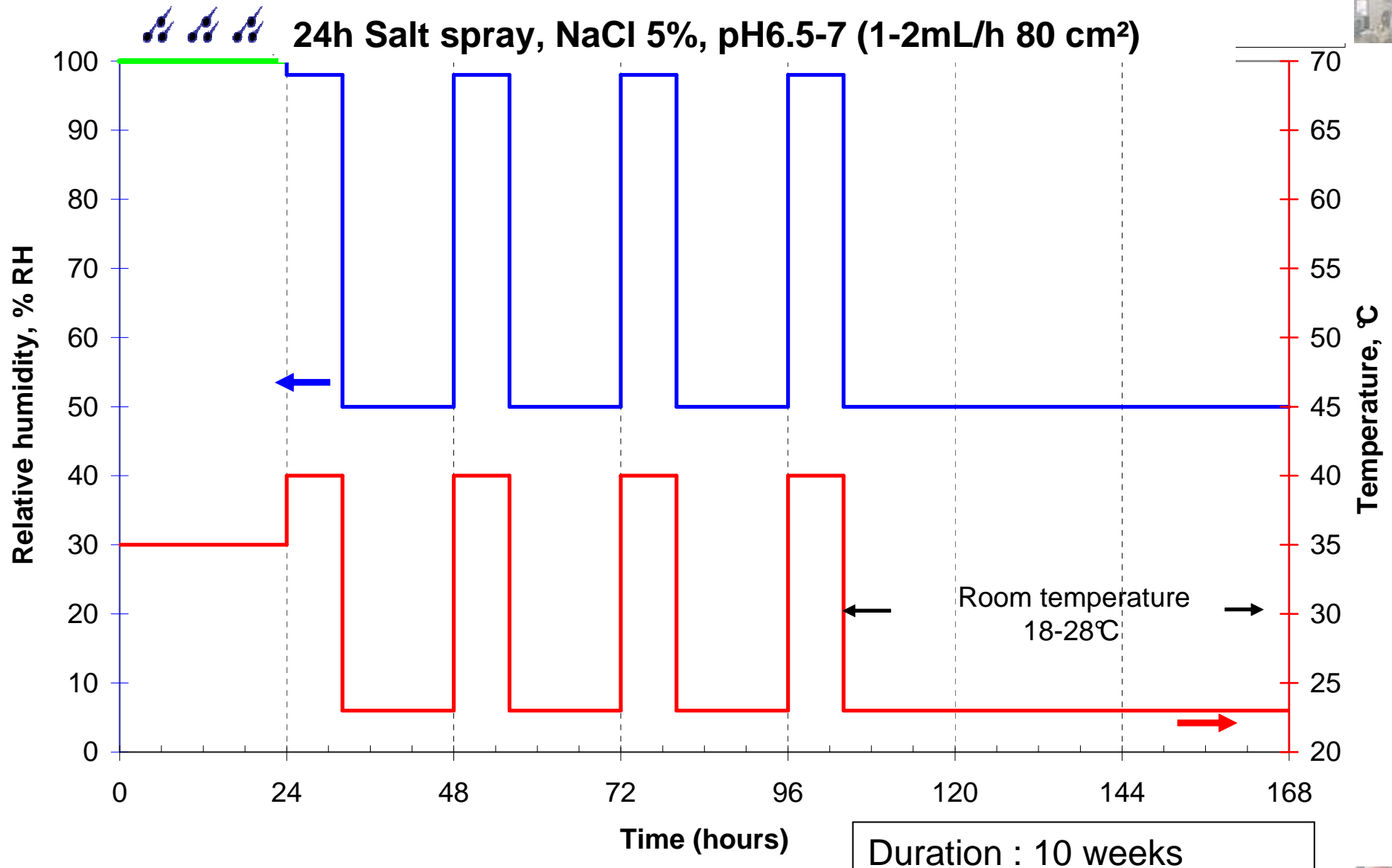
Experimental

1. Renault ECC1 D17 2028 : **ECC1**
2. Volvo STD423-0014 : **VICT**
3. VDA 621-415 : **VDA**
4. Scania STD 4233 : **SICT**
5. Daimler KWT : **KWT**
6. PSA TCAC D13 5486 : **TCAC**
7. New VDA (VDA233-102): **N-VDA**
8. Ford CETP 00.00-L-467: **Ford**
9. Test developed in FCI project: **VIC2**
10. Nissan M0158: **CCTIV**



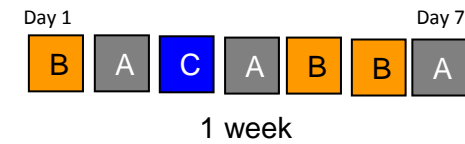
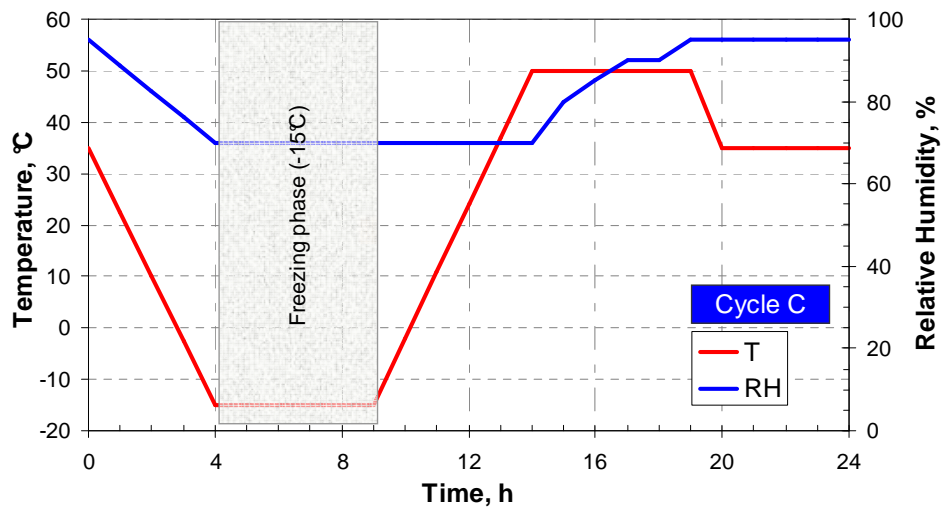
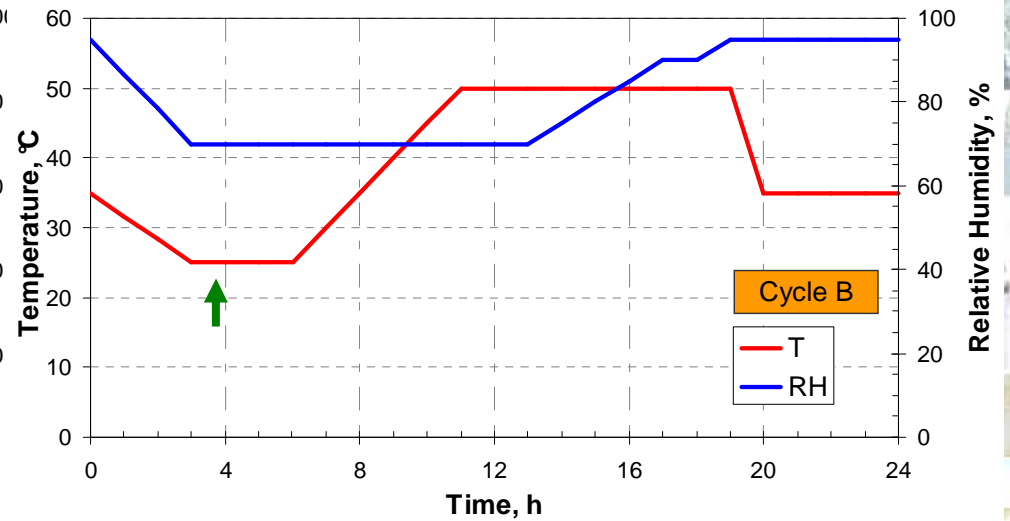
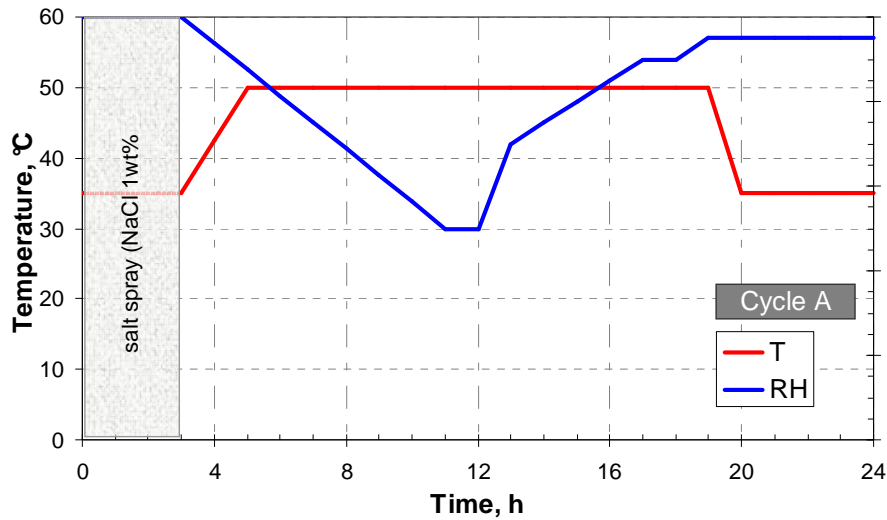
# VDA621-415

Experimental

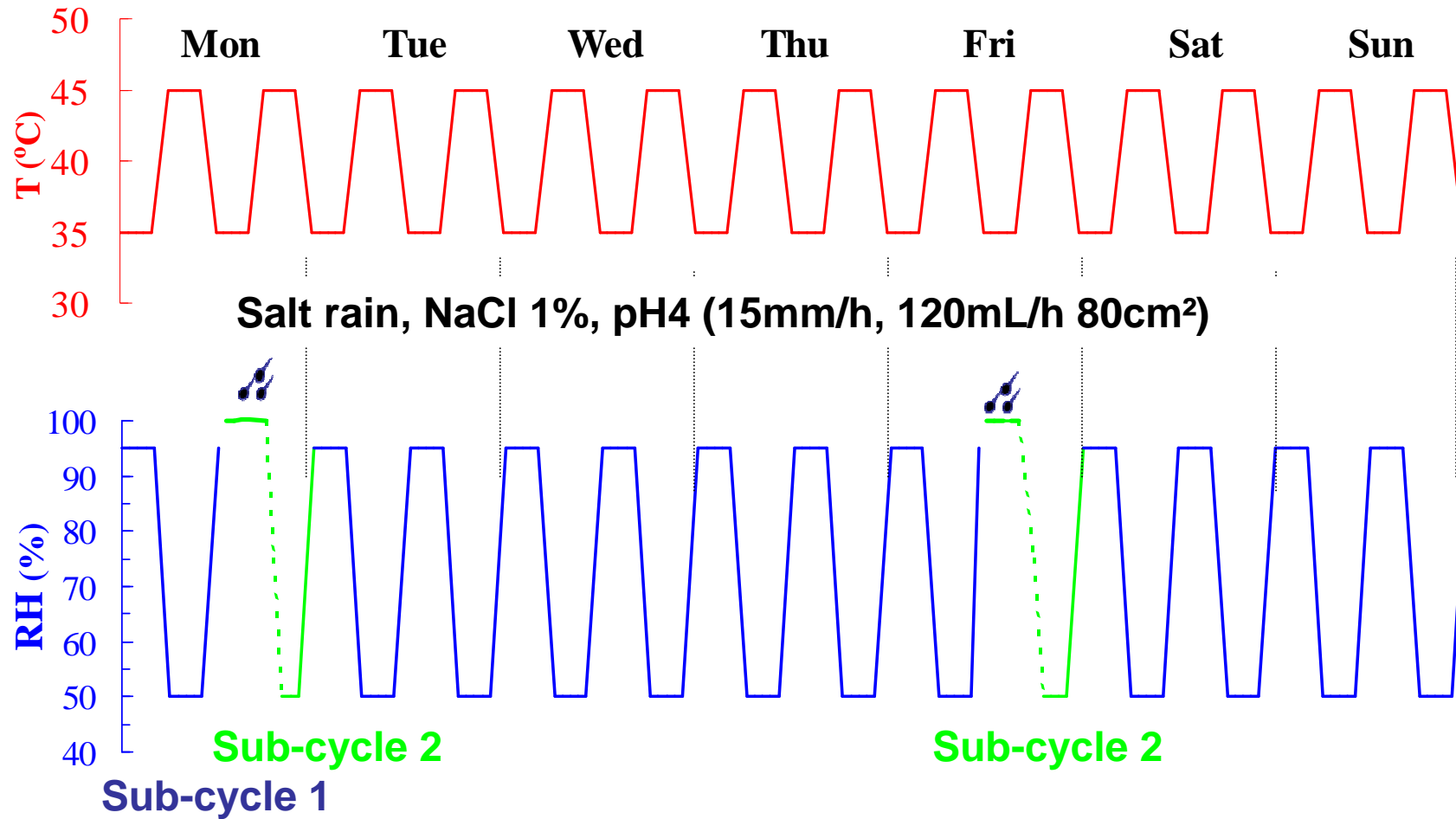


# New VDA – VDA233-102

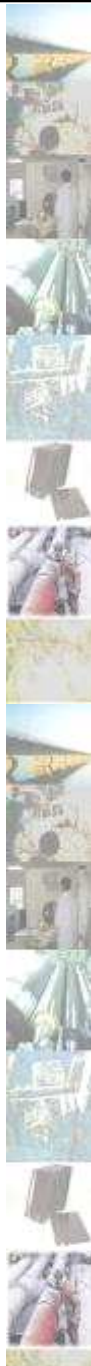
Experimental



# Volvo VCS1027,149 (STD 423-0014) Experimental



Duration: 6 weeks





Test chamber for VICT test





# Accelerated Corrosion tests

Experimental

	standard	Pollution			T.°C	R. H., %	duration, days
		Salt solution pH deposition rate in 80cm <sup>2</sup>	Frequency T°C	Cl deposition, mg/cm <sup>2</sup> , test <i>Approx.</i>			
1	Renault <b>ECC1</b> D172028	NaCl 1% wt, pH4 5mL/h	30min/day 3.5h/week	8	35.. ..20,1h35 35.. ..55,2h40 35.. ..90,1h20	42	
2	Volvo Car Corp <b>VICT</b> VCS1027,149 or STD 423-0014	NaCl 1% wt, pH4 120mL/h (15mm/h)	3x15 min twice a week 1.5h/week	27	45.. ..50, 4h 35.. ..95, 4h	42	
3	<b>VDA 621-415</b>	NaCl 5%wt, pH 6.5-7.2 1.5mL/h	24h/ week	136	40.. ..100, 8h 18-28.. ..50, 16h 23.. ..50, 48h	70	
4	Scania <b>SICT</b> STD4233 Or ISO 16701	NaCl 1% wt, pH4	Immersion 1h twice a week Ambiant	nd	35.. ..45, 2h 35.. ..90, 7h	84	
5	Daimler <b>KWT</b>	NaCl 1%wt , pH6.5-7.2, 2mL/h	2h/day (4 days) 8h/week	7.3	-15.. ..50 Up to 50. Up to 100	42	
6	PSA <b>TCAC</b> D13 5486	NaCl 1% wt, pH4 3mL/h	1h Twice a week	5.4	35.. ..85, 7h 35.. ..45	84	
7	New VDA ' <b>N-VDA</b> '	NaCl 1% wt, pH6.5-7.2 2mL/h	3h (3 times/week) 9h/week	8.1	-15.. ..50 Up to 50 Up to 100	42	
8	New Volvo/Ford CETP 00.00- L-467 ' <b>FORD</b>	NaCl 0.5% wt, ~120-160mL/h	10+3+3+3min/6h (wet phase) 5 days/weeks		25.. ..95, 6h 50.. ..70,15h30	42	
9	developed in FCI project SS0.5/T45/D70/C12/NS2 <b>VIC2</b>	NaCl 0.5% wt, pH4 120mL/h (15mm/h)	3x5 min twice a week 0.5h/week	13.6	45.. ..95, 4h 45.. ..70, 7h	42	
10	Nissan M 0158 <b>CCT IV</b>	NaCl 5%wt, pH 6.5-7.2 1.5mL/h	10min/day 1h10/week	4	60.. ..30, 160mn 60.. ..95, 80min	42	

NB: CCT IV difficult to run (10 min salt spray, climatic regulation)

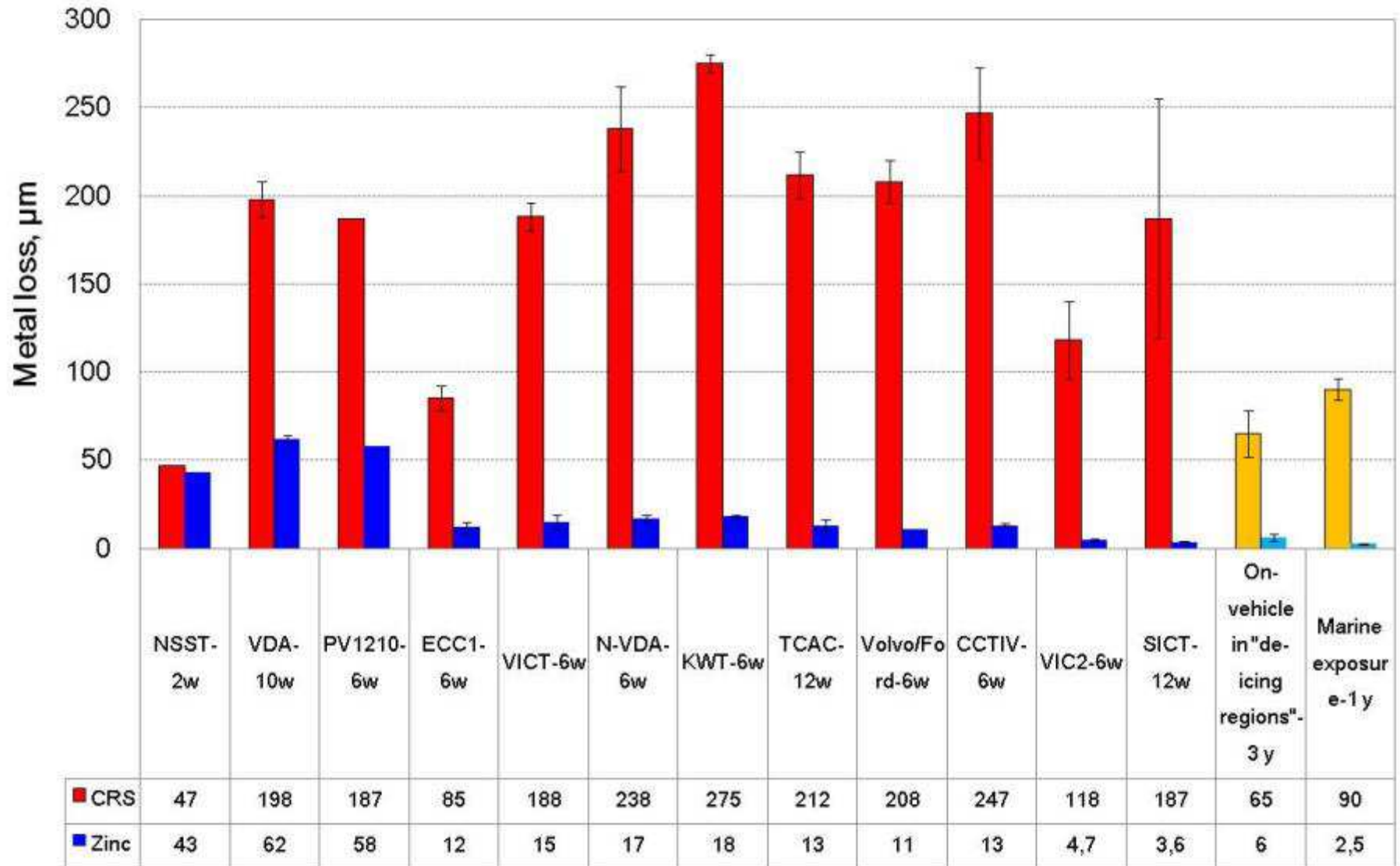


- 1. Bare materials**
- 2. Cosmetic panels**
- 3. Correlation between tests**
- 4. Comparison with on-vehicle exposure**



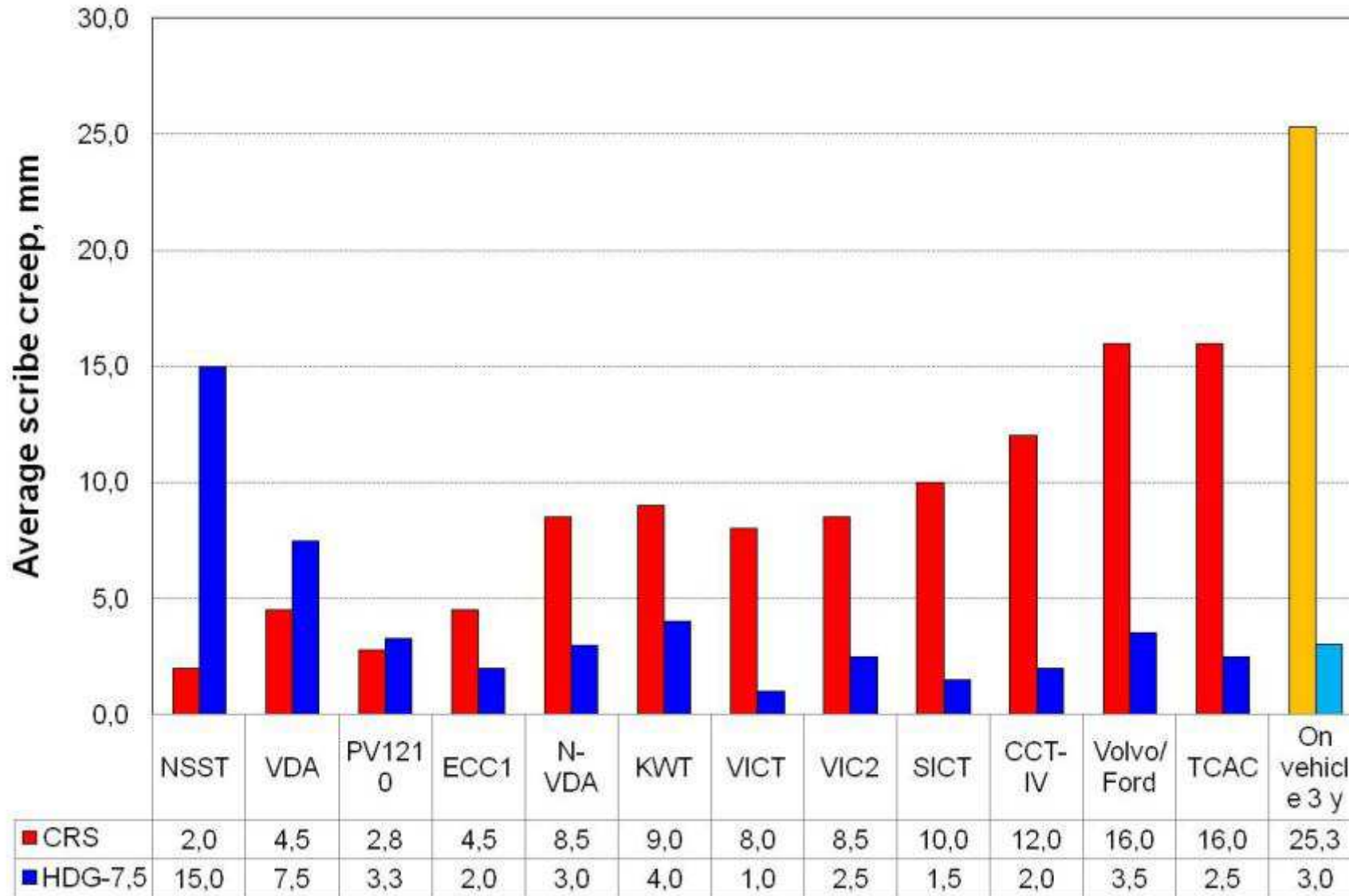
# 1- Bare materials: metal loss

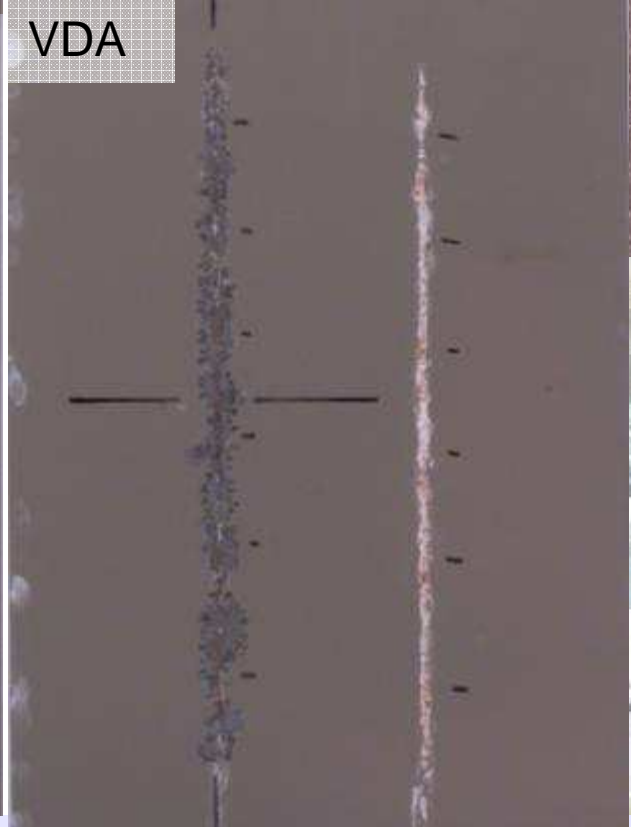
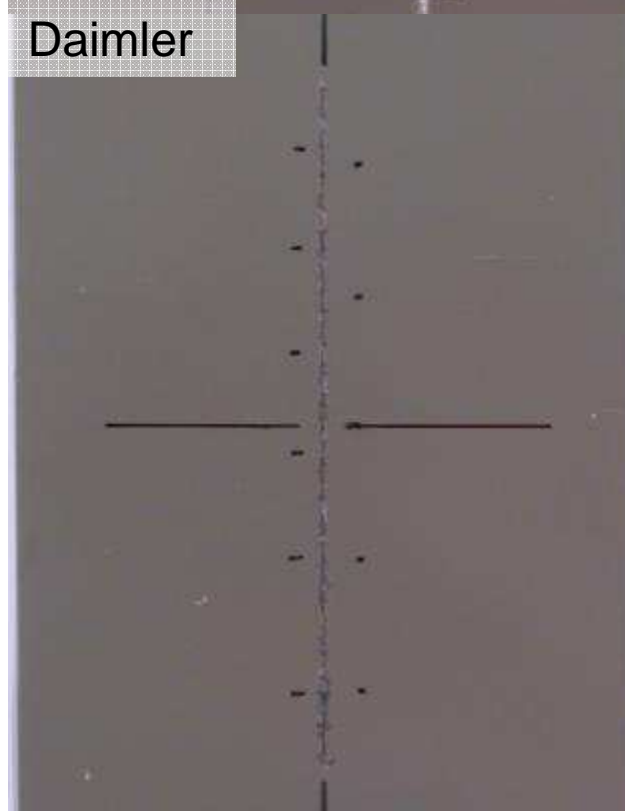
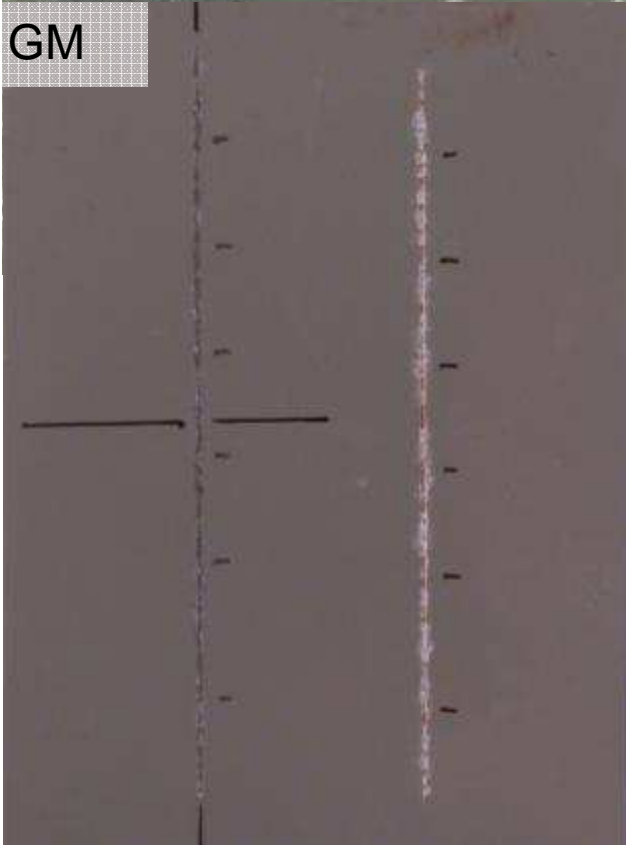
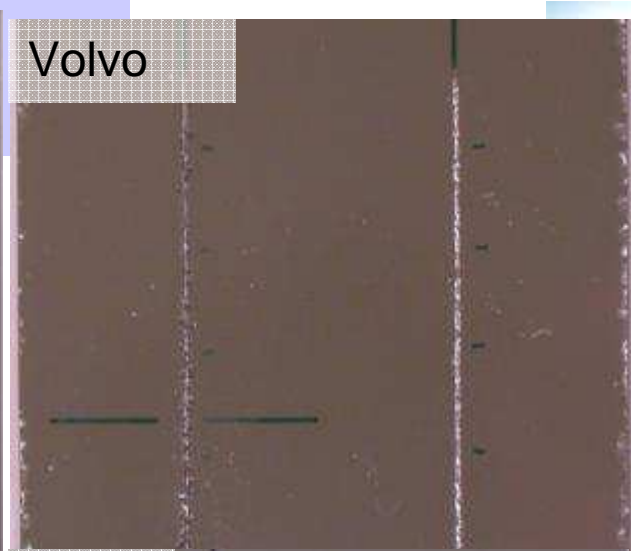
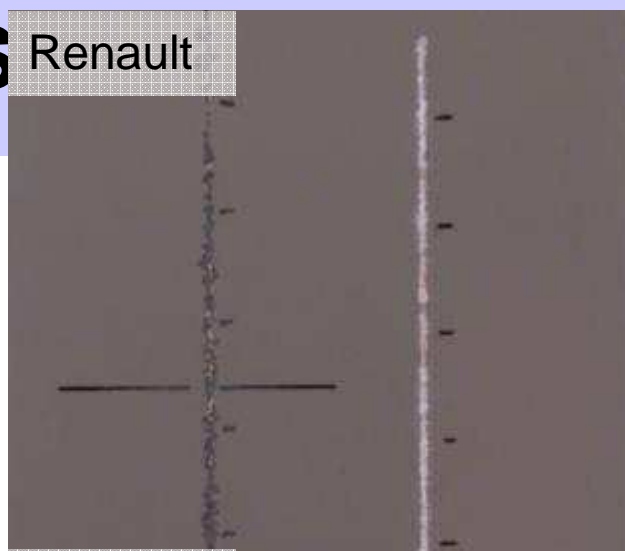
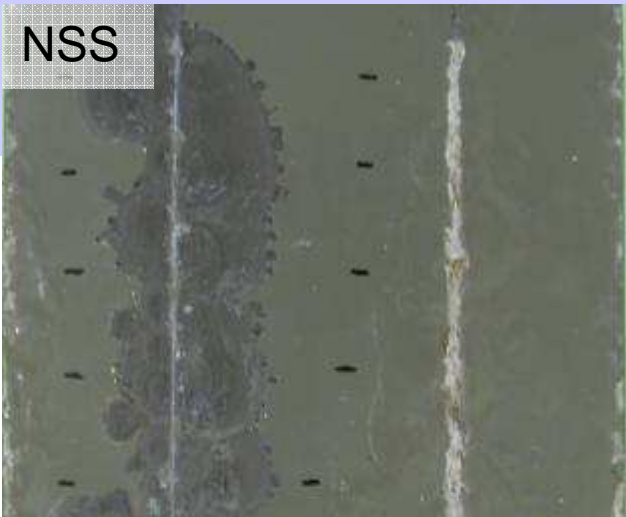
Results / Bare samples



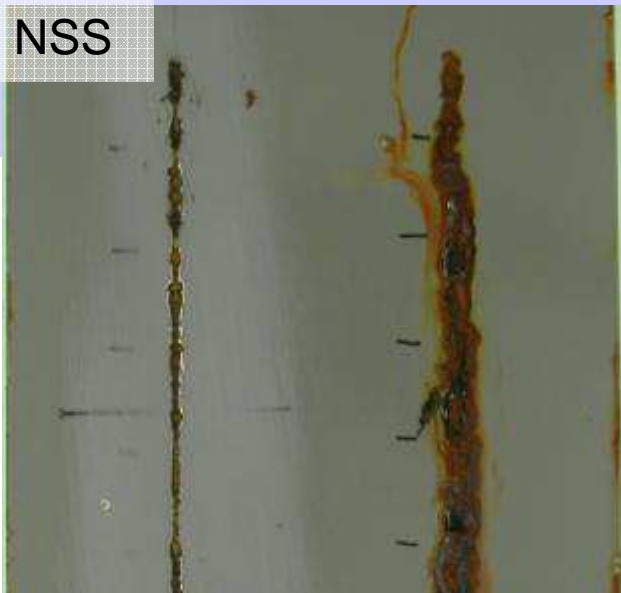
# 2-Painted panels : scribe creep

Results / cosmetic sample

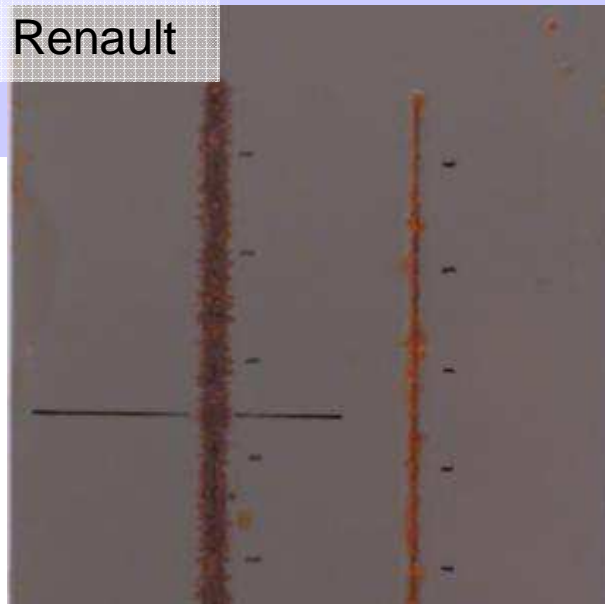




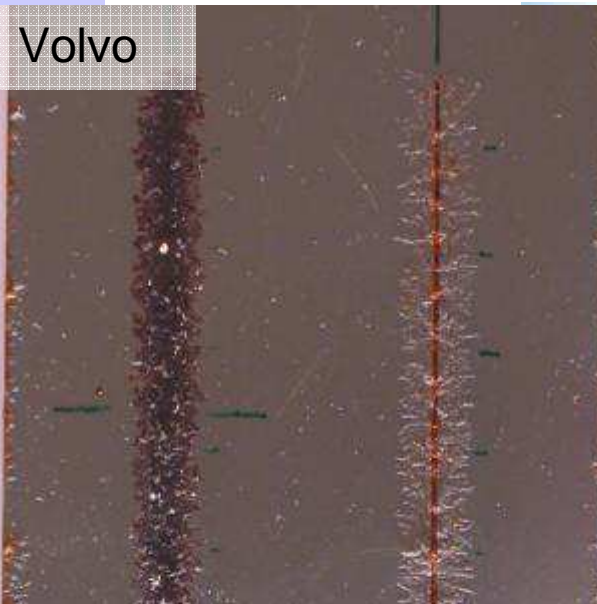
NSS



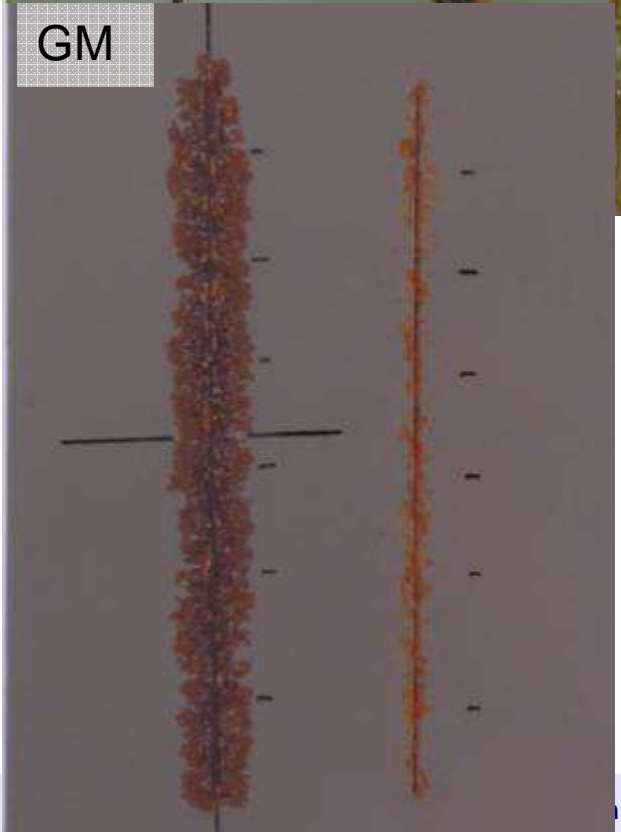
Renault



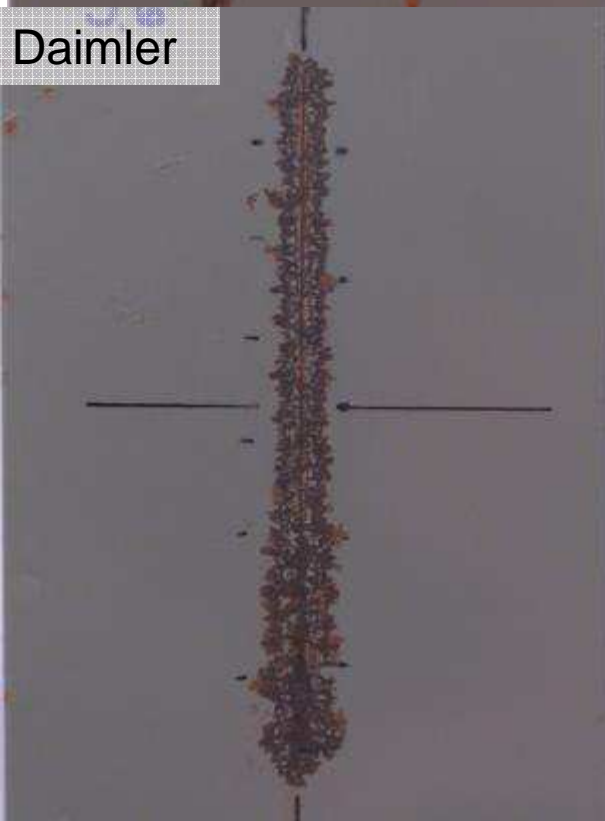
Volvo



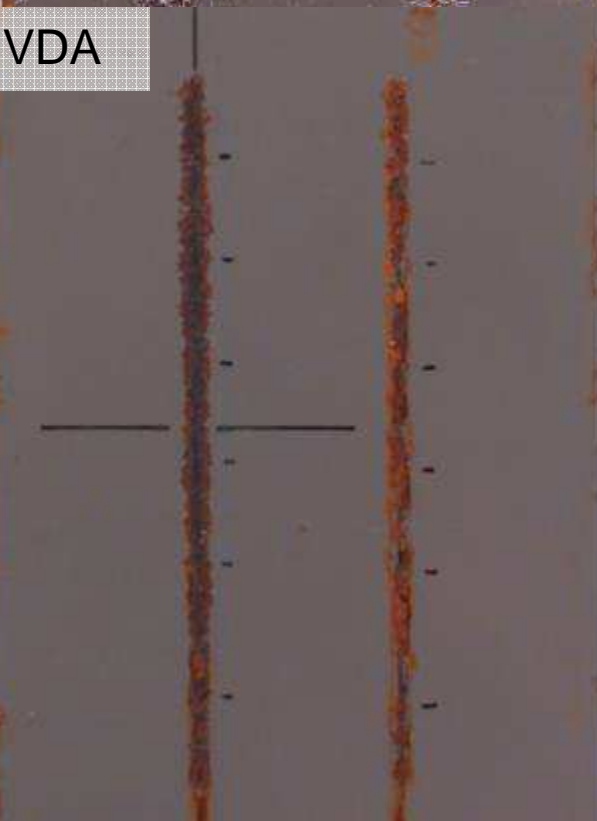
GM



Daimler

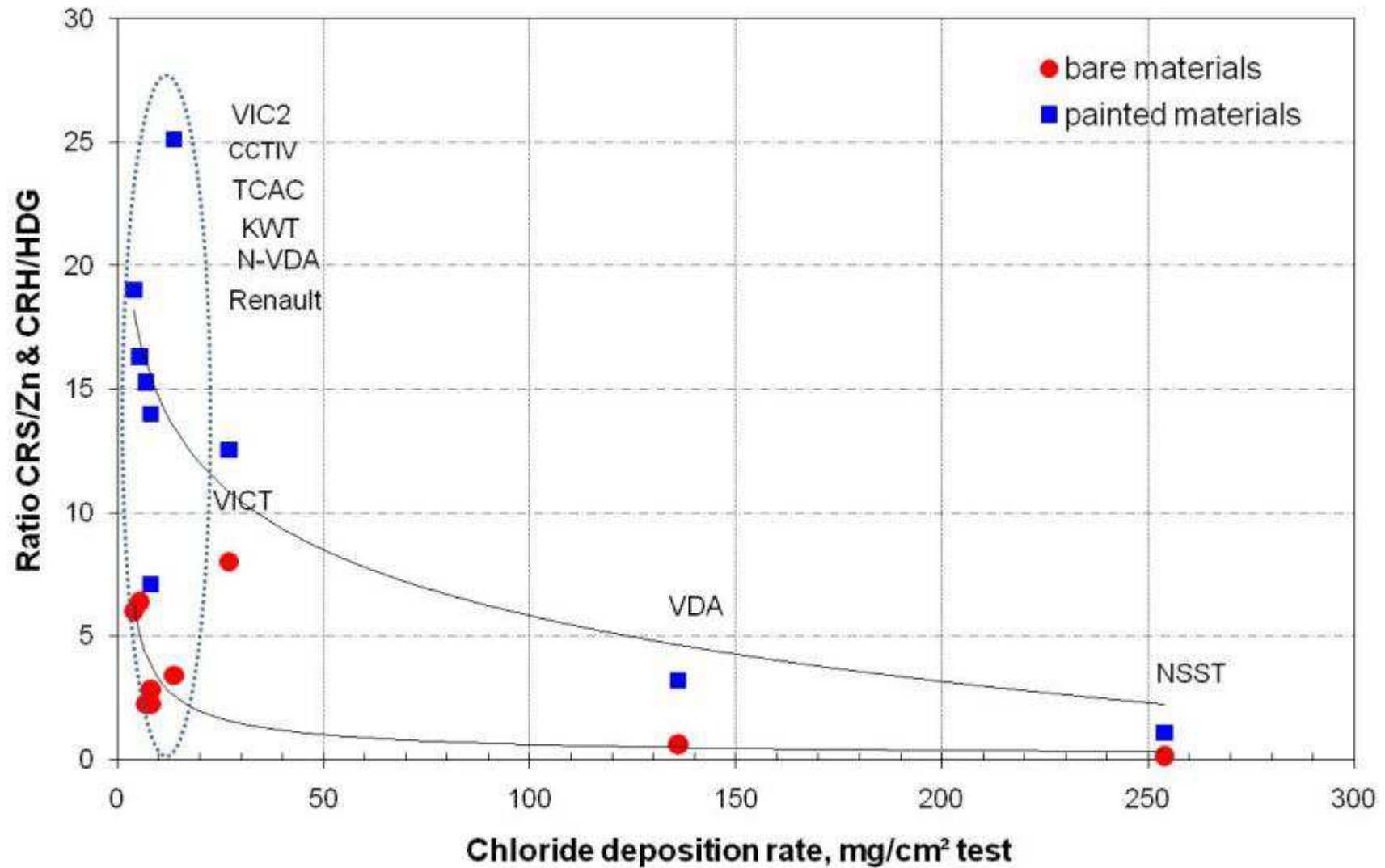


VDA



# Painted CRS & Zn-chloride load vs ratio CRS/Zn

Results / cosmetic sample



# 3-Correlations between tests

Results / test correlations



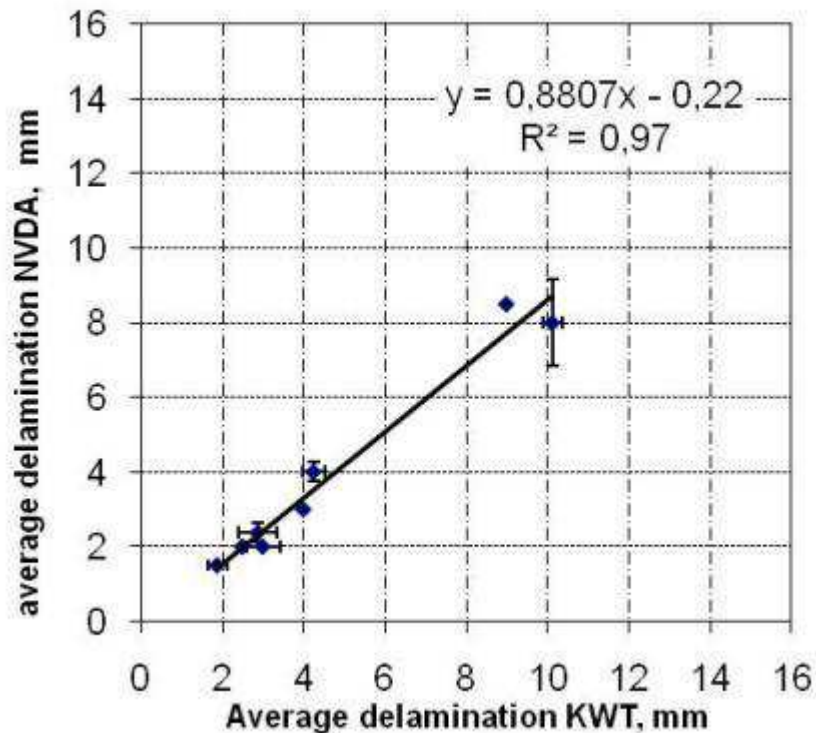
## Linear regression plot analysis

Coefficient of determination  $R^2$  :  $R^2 \sim 1$  = perfect correlation

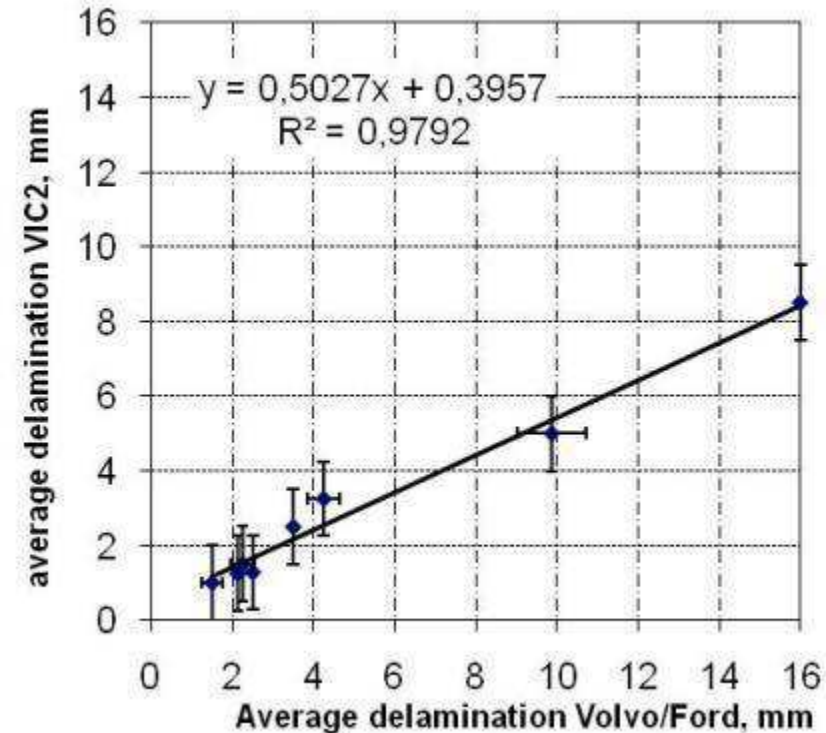
## Cosmetic steel based panels

## Correlation OK

$$N-VDA = f(KWT)$$



$$VIC2 = f(\text{Ford})$$

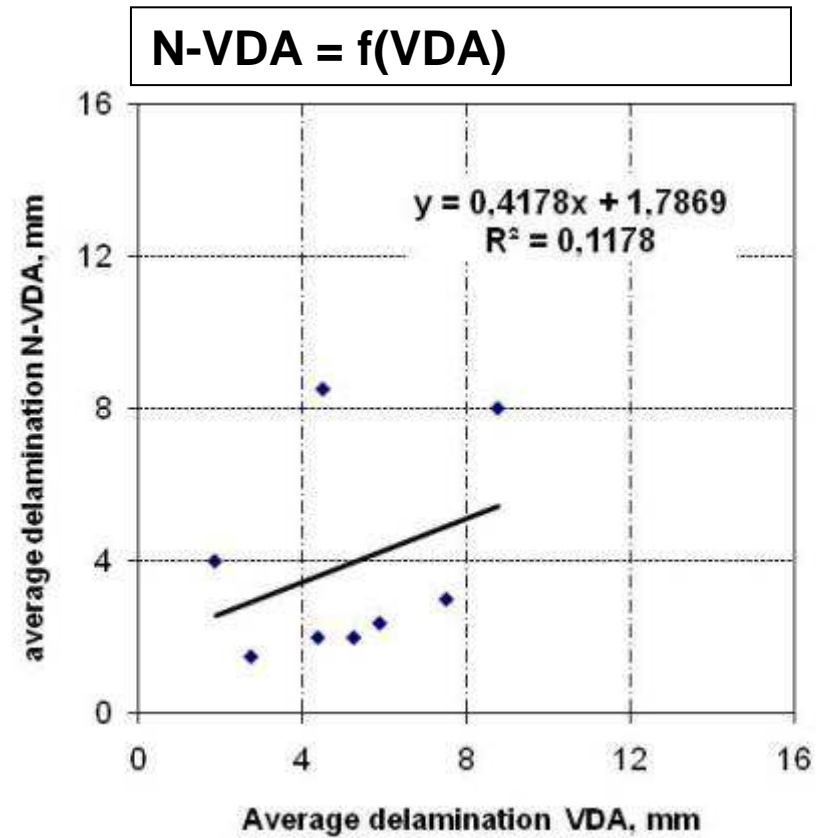
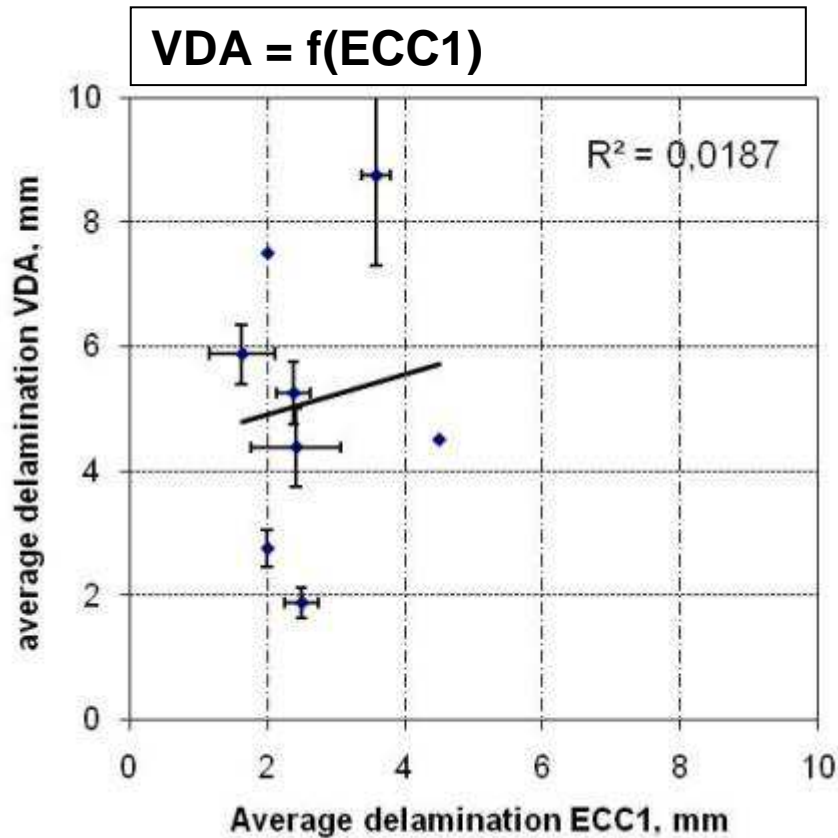




# Correlations between tests

Results / test correlations

Cosmetic steel based panels **No correlation**



# 4-Comparison with on-vehicle exp.

Results / Field data

Data from Worldwide exposure program (Sweden) – Source SwereaKimab

1	<b>Cosmetic corrosion (3 years)</b>	Delamination on coated steel substrate	CRS > HDG
2		Filiform corrosion on coated aluminium	Yes
3	<b>Metal loss on bare material (1 year)</b>	Steel, $\mu\text{m}$	~60-80
		Pure zinc, $\mu\text{m}$	~6



## Tendency

- **VDA** doesn't fulfil conditions 1, 2 and 3
- ⊖ - **ECC1**, **VICT**, **SICT** and **TCAC** don't fulfil conditions 2
- **SICT** and **TCAC** : 12 weeks of duration
- **CCT-IV** : difficult to run properly (short salt spray 10min, cycles)
  
- ⊕ **KWT**, **N-VDA**, **Volvo/Ford**, **VIC2** : quite satisfying results

# Conclusions (1/2)

## Performance Anticorrosion des systèmes automobiles = f(test accéléré)

Un système peut être accepté par un constructeur et rejeté par un autre!

- **Test VDA** exagère la corrosion du zinc/substrats zingués ~ comparable au **brouillard salin**
- **Test VDA** ne corrèle pas avec les autres tests accélérés
- **Corrélation acceptable:**
  - **N-VDA** et Daimler **KWT**
  - PSA **TCAC** et Scania **SICT** (12 semaines)
  - **Ford** et Renault **ECC1**, Volvo **VICT**, **N-VDA** et **VIC2**



# Conclusions (2/2)

## Comparaison avec résultats de terrain (exp. sur véhicules)

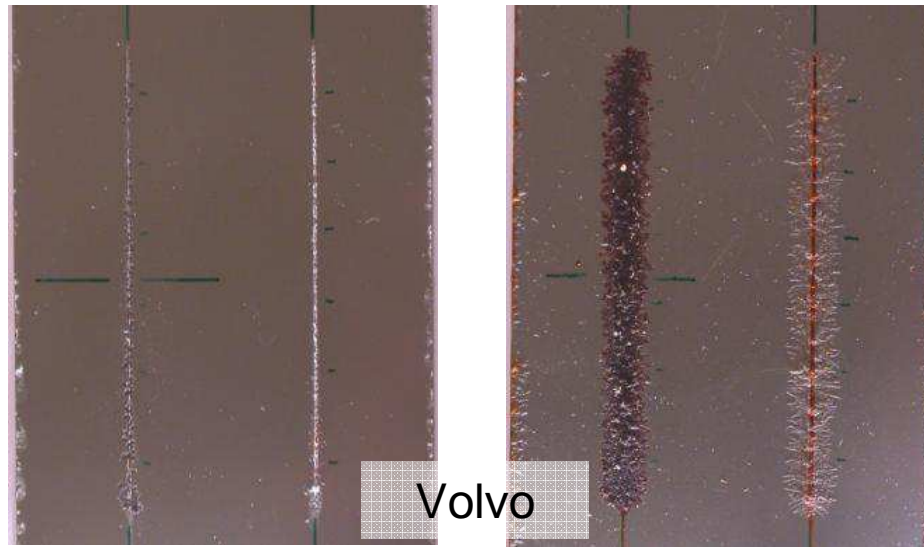
- **N-VDA, Daimler KWT, Ford ou VIC2**
- **VDA test**
- **VICT, ECC1, SICT ou TCAC**



Les résultats de terrains peuvent varier selon la localisation sur véhicules, la zone géographique, le kilométrage

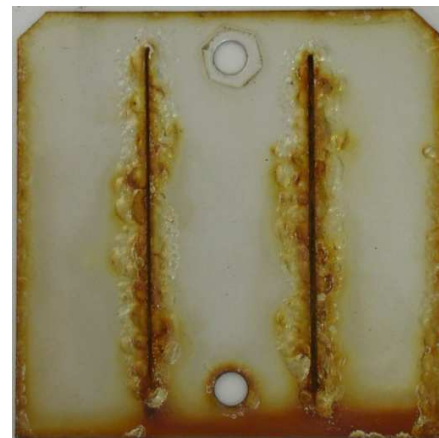
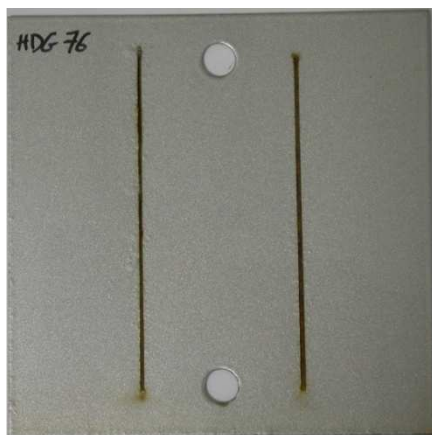


## Gamme automobile



HDG

Acier



5 ans sur véhicule (Fr, Alpes)

## Autre



Extrait plaquette

≠

12 ans garantie anticorrosion perforation



# Remerciements

- Arcelormittal
- Daimler
- Fiat
- JFE Steel
- Opel
- PSA
- Renault
- Sapa technology
- Scania
- ThyssenKrupp Steel
- voestalpine
- Volvo 3P
- Volvo Car Corp

