# Cashew Nutshell Liquid Based Polyols: Performances in flooring coating applications

Cardolite Corporation
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- CNSL based polyols and their performances in polyurethane flooring applications

  - Typical properties

  - Performances in 2K clear PU flooring coatings

  - Performances in 2K pigmented PU flooring coatings

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# Cardolite Polyols

| Products | NX-9005 | NX-9011 | NX-9014 |
|---|---|---|---|
| OH value (mg KOH/g) | 170 | 224 | 256 |
| Viscosity @25°C (cps) | 3000 | 1710 | 1200 |
| Functionality | 3.2 | 3.1 | 4.3 |
| Color (Gardner) | ≤5 | ≤5 | ≤5 |
| Comments | Chemical offset of Sovermol 805/1080 Flexibility | Offset of D1145 Hard and Toughness | High strength, better color stability |

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# Isocyanates

| Properties | Desmodur MDI 44V20 | WAMMATE HT-100 (HDI) |
|---|---|---|
| NCO content (%) | 30.5 ~ 32.0 | 21.7 ~ 22.2 |
| Viscosity @ 25°C (cps) | 150 ~ 250 | 2,500 ± 750 |
| NCO equivalent value | 133.3 | 200 |
| Density@ 25°C (g/cm$^3$) | 1.22 ~ 1.25 | / |

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# 2K clear PU systems

- CNSL-based polyols

  - Fast hardness development

  - Good mechanical properties

  - Good chemical resistance

# 2K clear PU formulations

| PART A | NX-9005/g | NX-9011/g |
|---|---|---|
| NX-9005 | 95.7 | / |
| NX-9011 | / | 95.7 |
| BYK-054 (Defoamer) | 0.5 | 0.5 |
| Incozol 2 (Moisture scavenger) | 3.0 | 3.0 |
| BYK – 354 (Leveling agent) | 0.5 | 0.5 |
| SUBTOTAL | 99.7 | 99.7 |
| PART B: Desmodur MDI 44V20 | 42.7 | 56.9 |
| TOTAL | 142.4 | 156.6 |
| Admixing viscosity/cps | 1866 | 953 |
| Gel time/mins | 45 | 52 |

Desmodur MDI 44V20: Polymeric MDI
NCO:OH ratio = 110:100

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# Hardness development

Shore D hardness development @ 25°C
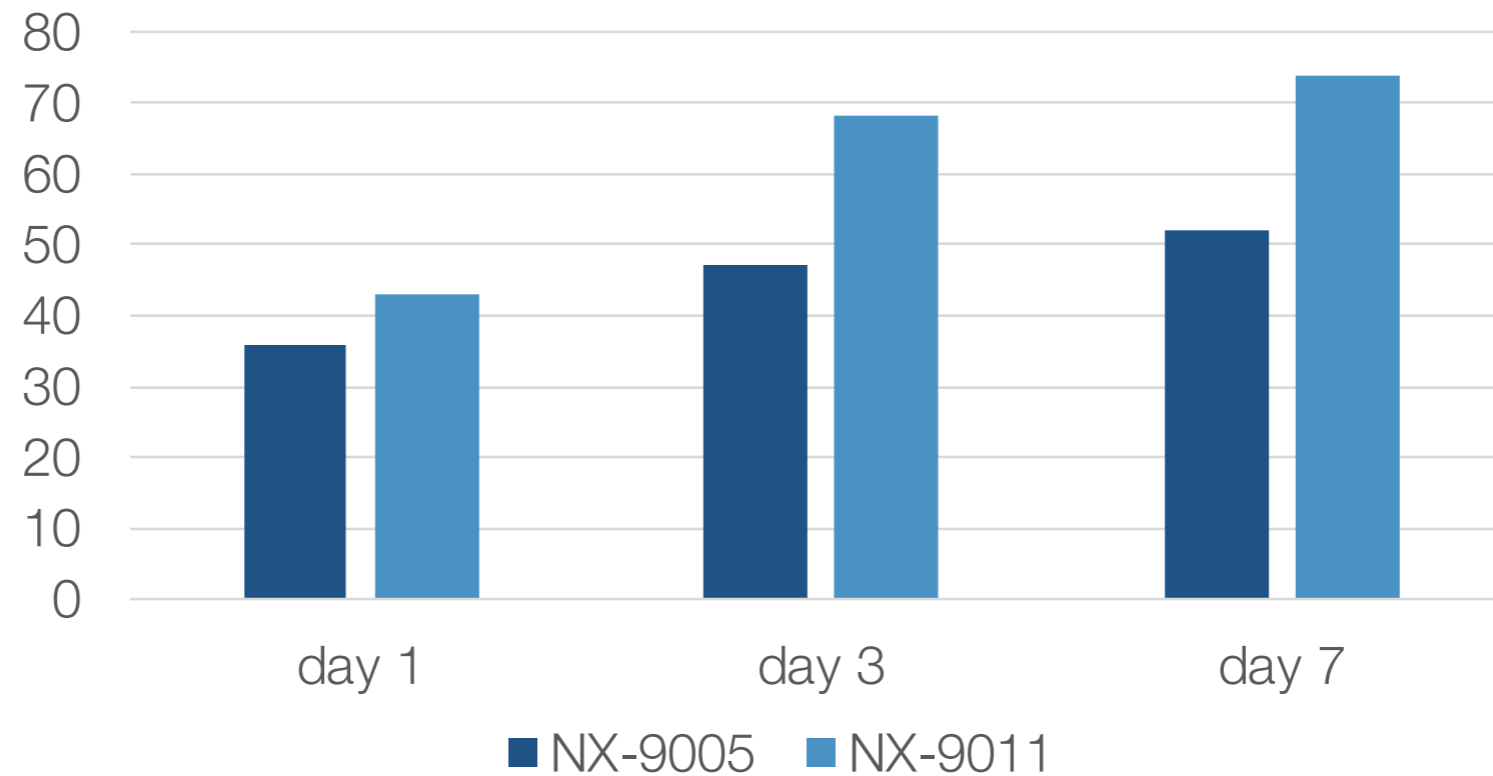


Desmodur MDI 44V20: Polymeric MDI
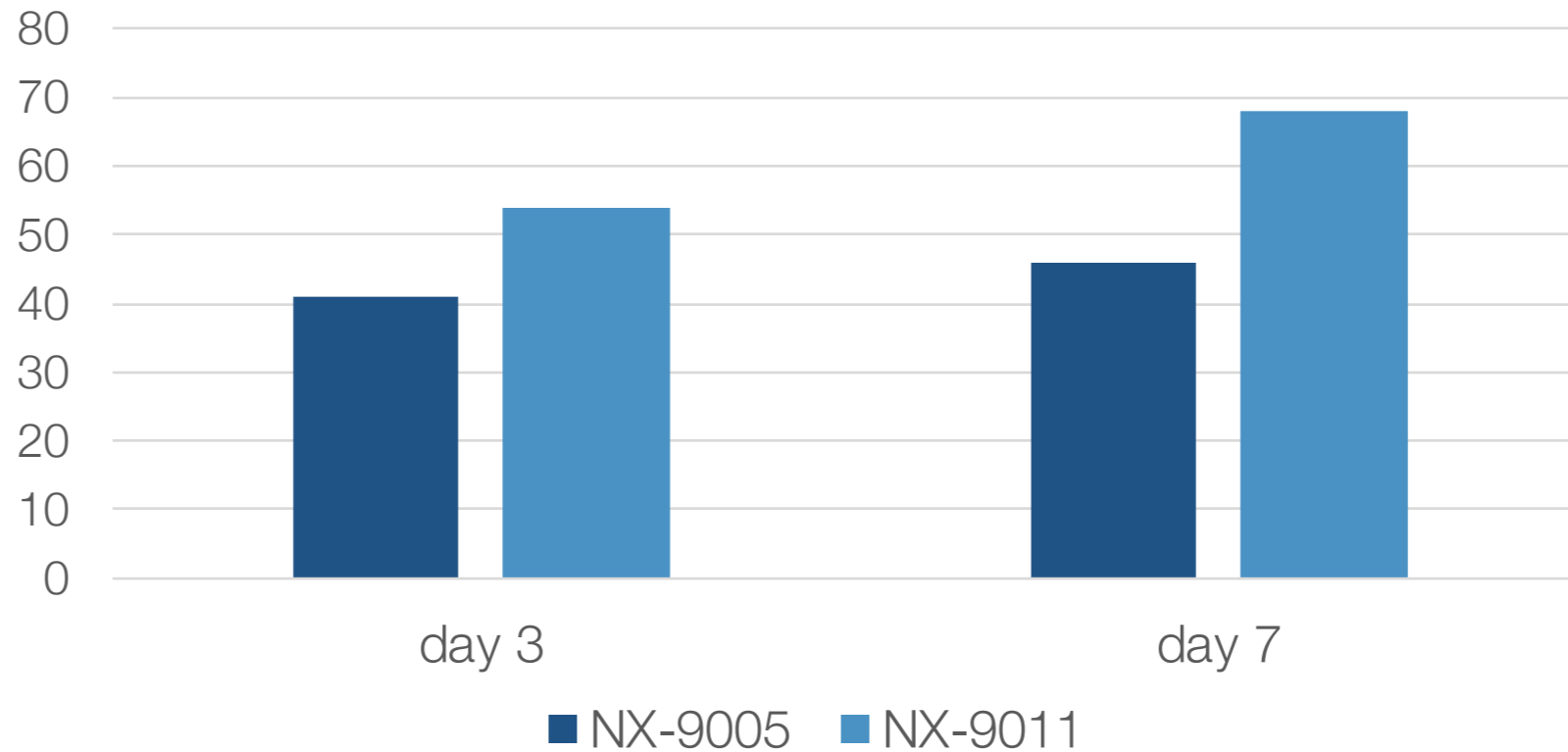NCO:OH ratio = 110:100

NX-9005 and NX-9011 showed fast  hardness development

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# Hardness development

Shore D hardness development @ 10°C+60-85%RH



Desmodur MDI 44V20: Polymeric MDI
NCO:OH ratio = 110:100

NX-9005 and NX-9011 exhibited good hardness development at low temperature

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# 2K clear PU systems

| Mechanical properties | | NX-9005 | NX-9011 |
|---|---|---|---|
| Mandrel Bend | | 1/8" pass | 1/8" pass |
| Impact resistance Kg·cm | Direct | 200 | 200 |
| | Reverse | 200 | 200 |
| Cross-hatch adhesion (over QD-36 CRS substrate) | | 5B | 5B |
| Compression strength, MPa (at yield point) | | no yield points detected, elastomeric PU system | 25 |

Desmodur MDI 44V20: Polymeric MDI
NCO:OH ratio = 110:100
Cure condition: 7 days at 25 °C/40-60%RH

➢ NX-9005 and NX-9011 systems exhibited very good flexibility and adhesion performance
➢ NX-9005 based PU system demonstrated excellent elastic performance at room temperature (compression test did not show measurable yield points)

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# Film appearance
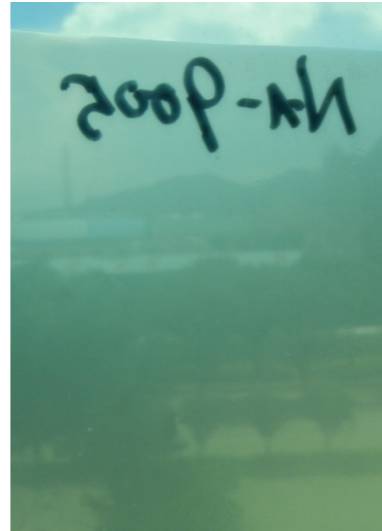
| Gloss | NX-9005 | NX-9011 |
|-------|---------|---------|
| 20° | 95.6 | 96.6 |
| 60° | 81.2 | 83.4 |

Desmodur MDI 44V20: Polymeric MDI
NCO:OH ratio = 110:100
Cure condition: 7 days at 25 ˚C/40-60%RH

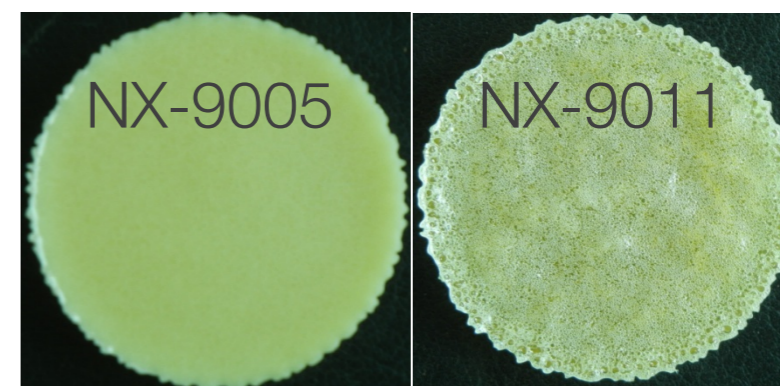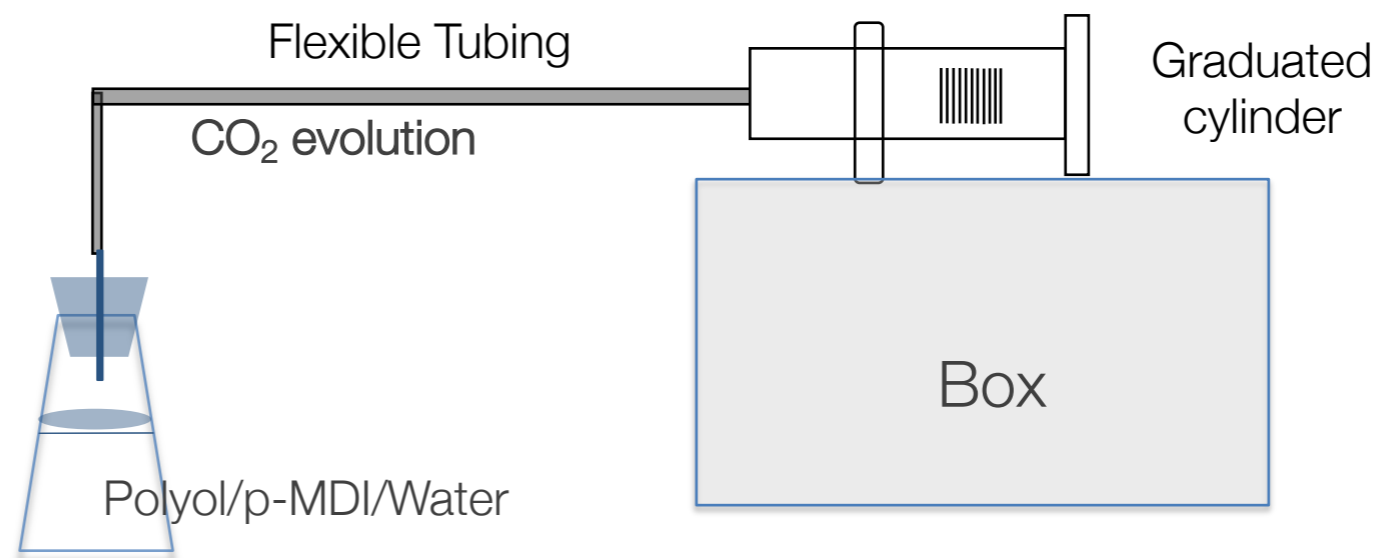NX-9005 and NX-9011 systems showed high gloss films

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# Moisture sensitivity

| Formula | CO$_2$ (ml) after 24hr |
|---|---|
| 100g of polyol/p-MDI +100g of water) | |
| NX-9005/PMDI | 16 |
| NX-9011/PMDI | 36 |
| NX-9001/PMDI | 5 |
| NX-9001LV/PMDI | 5.8 |

Polymeric MDI(PMDI): PAPI27



NX-9005    NX-9011

Cured at 28-34°C, 65-95%RH

Flexible Tubing

Graduated cylinder

CO$_2$ evolution

Box

Polyol/p-MDI/Water

➢Reduction on CO$_2$ evolution indicates less moisture sensitivity
➢NX-9005 exhibited better hydrophobicity: reduced moisture sensitivity
➢NX-9005 system was less affected by high humidity cure condition

# Chemical resistance

**NX-9005 chemical immersion**

Legend: Skydrol, Diesel, 10% H2SO4, 50% NaOH, D.I water 50°C, 3.5% Salt water 50°C

**NX-9011 chemical immersion**

Legend: Skydrol, Diesel, 10% H2SO4, 50% NaOH, D.I water 50°C, 3.5% Salt water 50°C
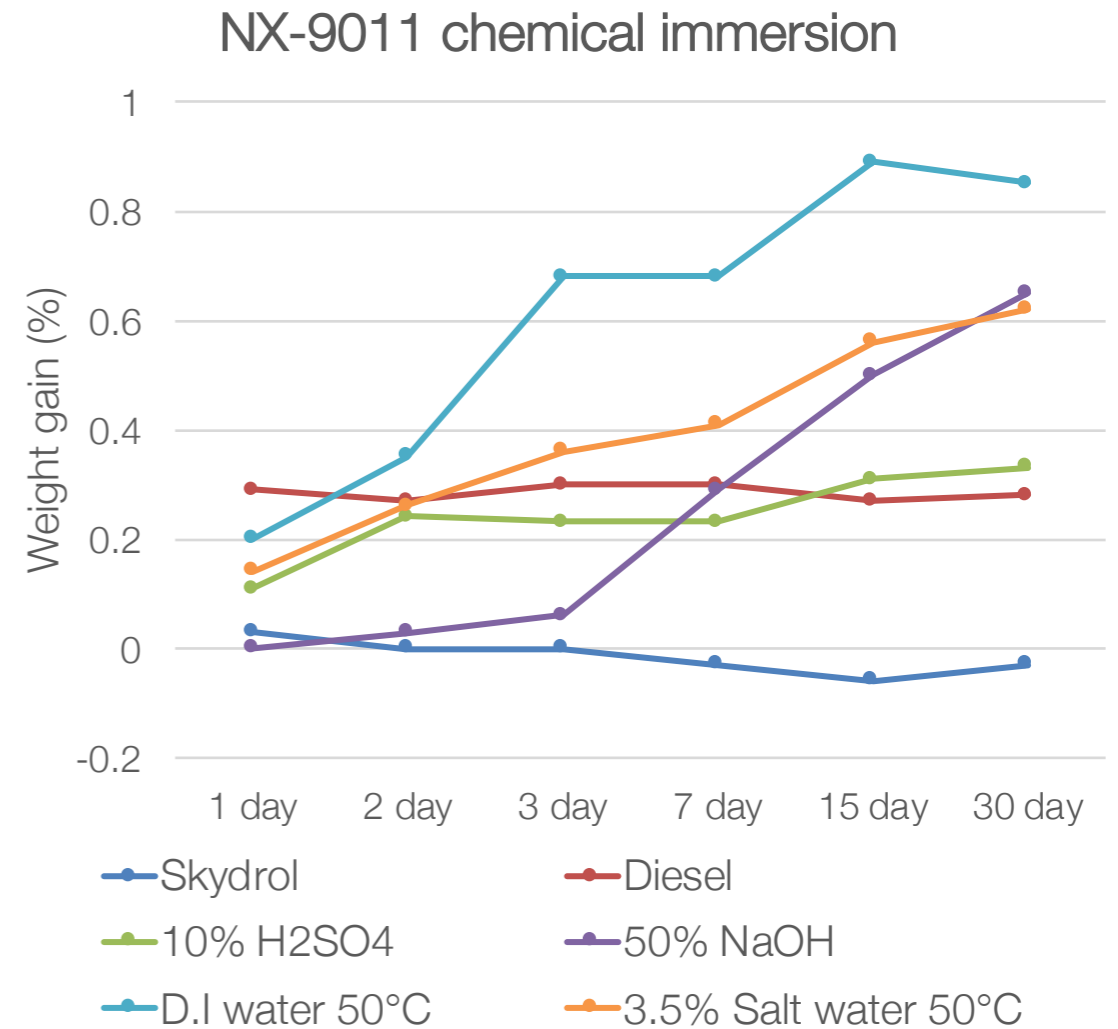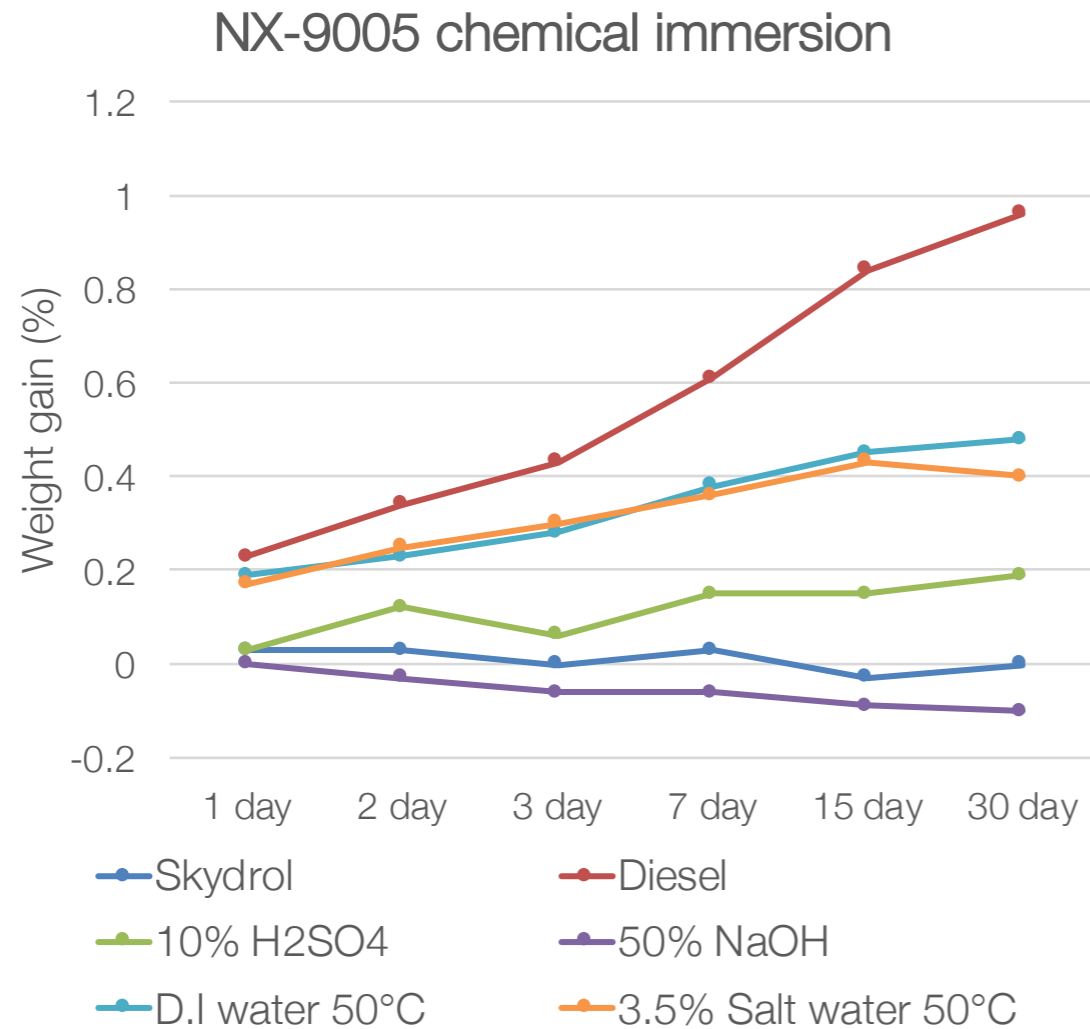
➢ NX-9005 and NX-9011 systems showed good chemical resistance to acid, alkaline, salt solutions, skydrol and Diesel.
➢ Improved alkaline resistance can be achieved by NX-9001

Desmodur MDI 44V20: Polymeric MDI
NCO:OH ratio = 110:100
7-day RT cure before immersion test

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# 2K pigmented PU systems

- CNSL-based polyols

  - Balanced cure properties

  - Good mechanical properties

  - Improved color stability

| PART A | NX-9005/g | NX-9011/g | NX-9014/g |
|---|---|---|---|
| NX-9005 | 36.7 | / | / |
| NX-9011 | / | 36.7 | / |
| NX-9014 | / | / | 36.7 |
| Disperbyk-110 (dispersant) | 4.0 | 4.0 | 4.0 |
| BYK-054 (defoamer) | 0.5 | 0.5 | 0.5 |
| Incozol 2 (moisture scavenger) | 3.0 | 3.0 | 3.0 |
| TiO2 R-706 (pigment) | 6.0 | 6.0 | 6.0 |
| Barium sulfate (filler) | 16.5 | 16.5 | 16.5 |
| Silica sand (filler) | 11.0 | 11.0 | 11.0 |
| DBTDL (catalyst) | / | 0.03 | 0.03 |
| BYK 354 (leveling agent) | 1.0 | 1.0 | 1.0 |
| Bentone SD-27 (rheological additive) | 0.5 | 0.5 | 0.5 |
| PART B: WAMMATE HT-100 (HDI) | 23.4 | 30.9 | 36.1 |
| TOTAL | 102.5 | 113.0 | 119.7 |

NCO:OH ratio = 110:100

# 2K pigmented PU formulations

# 2K pigmented PU systems

| Properties | Admixing viscosity at 25 ℃/cps | Gel time at 25 ℃/mins |
|---|---|---|
| NX-9005 | 29014 | > 240 |
| NX-9011 | 5309 | 289 |
| NX-9014 | 5549 | 154 |

NX-9011 and NX-9014 had medium admixing viscosities and long gel times

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# Shore A/D hardness

| Systems | Cure Temp. | Day 1 | Day 3 | Day 7 |
|---------|------------|-------|-------|-------|
| NX-9005 |  | Soft | 43 (A*) | 66(A*) |
| NX-9011 | 25°C | 67(A*) | 16(D*) | 23(D*) |
| NX-9014 |  | 75(A*) | 21(D*) | 27(D*) |
| NX-9005 |  | / | / | / |
| NX-9011 | 10°C | Soft | 75(A*) | 23(D*) |
| NX-9014 |  | 49(A*) | 81(A*) | 28(D*) |

A* = Shore A
D* = Shore D

NX-9011 and NX-9014 systems exhibited good hardness development when combined with HDI type isocyanate

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# Mechanical properties

| Mechanical properties | | NX-9005 | NX-9011 | NX-9014 |
|---|---|---|---|---|
| Mandrel Bend | | 1/8" pass | 1/8" pass | 1/8" pass |
| Impact resistance Kg·cm | Direct | 200 | 200 | 200 |
| | Reverse | 200 | 200 | 200 |
| Cross-hatch adhesion (over QD-36 CRS substrate) | | 4B | 5B | 4B |
| Abrasion  (1000 cycle/mg) | | / | 78 | 80 |

Cure condition: 7days at 25 ℃/40-60%RH

➢ NX-9005, NX-9011 and NX-9014 showed very good flexibility and adhesion
➢ Good abrasion resistance can be achieved by NX-9011 and NX-9014
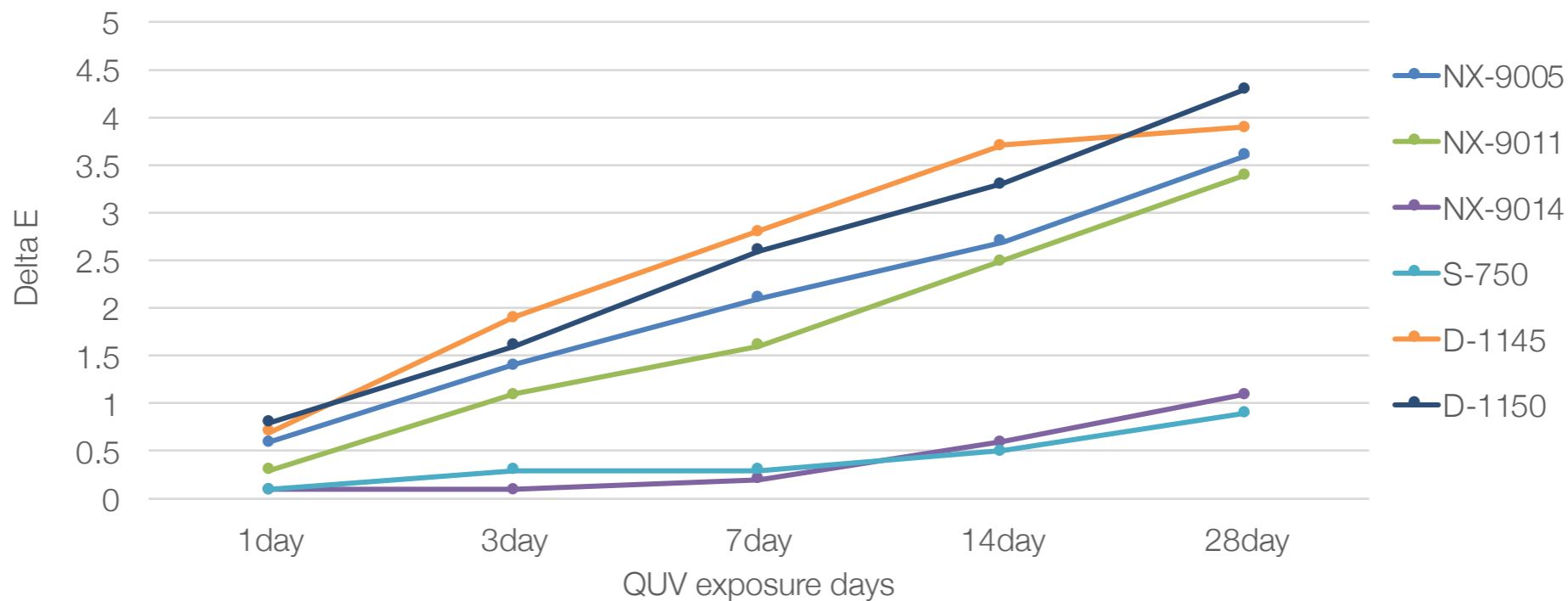
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# Film appearance

| Gloss | NX-9005 | NX-9011 | NX-9014 |
|-------|---------|---------|---------|
| 20° | 45.4 | 32.8 | 15.7 |
| 60° | 78.3 | 75.5 | 55.6 |

Cure condition: 7days at 25 ℃/40-60%RH

For pigmented PU systems, CNSL-based polyols provided mat films with medium glosses.

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Delta E vs QUV exposure days (1day, 3day, 7day, 14day, 28day) for NX-9005, NX-9011, NX-9014, S-750, D-1145, D-1150

| PART A | Weight |
|---|---|
| POLYOLS (NX-9005, NX-9011, NX-9014, S-750,D-1145, D-1150) | 38.94 |
| BYK-163 | 0.56 |
| TITANIUM  DIOXIDE | 22.32 |
| MICA | 28.08 |
| BARIUM SULFATE | 10.10 |
| TOTAL | 100 |
| PART B: Desmodur N-3390 | 25.37/26.12/33.43/38.20/47.84/34.92/23.14 |

Desmodur N-3390: Aliphatic polyisocyanate (HDI trimer)
Cure condition: 7days at RT

NX-9014 exhibited excellent color stability, similar to Sovermol 750

# QUV color stability

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# CNSL Polyols

- Cardolite offers renewable polyols – NX-9005, NX-9011 and NX-9014 for 2K Polyurethane flooring applications

- NX-9005 and NX-9011 combined with polymeric MDI could offer fast cure, good hardness development and excellent chemical resistances

- In 2K pigmented systems, NX-9011 and NX-9014 combined with HDI could provide medium admixing viscosity, long pot life, reasonable cure speed and excellent flexibility, adhesion and abrasion resistance

- NX-9011 and NX-9014 have low colors, especially NX-9014 exhibited very good color stability

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