High performance water based acrylic resins for DIY garage floor paints

Dr. Andrew Hearley
R&D Manager (Europe)

Science Simplified

co-authors: Howard Killilea, Carl Weber and Mike Wildman
1K DIY *waterbased* systems for garage floor* coatings

*(walkways, patios, car ports, tiles, garden ornaments etc…)*

**Market Expectations**

- Ease of use (DIY Market)
- Decorative – has to look nice
- Environment – must fulfill the latest legislation (*e.g.* Eco-label 2015)
- Cost effective
- Performance – *must do the job it is designed to do!!*

- Easy to apply, looks good, performance, environmentally friendly and cost effective
1K DIY *waterbased* systems for garage floor* coatings

*(walkways, patios, car ports, tiles, garden ornaments etc…)*

**State-of-the-Art**

- Wide range - Pure Acrylic / styrene acrylic / PUD-acrylic blends
- Direct to concrete or together with a bonding primer
- Many products are epoxy modified
- Lower performance *versus* a 2K products

So, *what are the deficiencies in the current technology?*
1K DIY waterbased systems for garage floor* coatings *(walkways, patios, car ports, tiles, garden ornaments etc…)

Modes of failure

1. Delamination from standing water -

2. Hot Tyre Pick-up -

3. Staining from tyres and dirt -

4. Discoloration, softening or delamination from chemicals -

✓ Technically challenging
Next Generation Polymer Design

Acrylic
• Hydrophobic to form a chemically resistance barrier

Proprietary adhesion monomer
• Wet and dry adhesion to concrete/ glass / tiles

Fine particle size
• Penetrates to seal pores / aids adhesion / reduces blush

Particle Morphology
• Balance of hardness/ flexibility / lowers MFFT / reduces blushing

Novel x-linking technology (Adipic dihydrazide free)
• To improve both chemical & dirt resistance / hot tyre pick-up

Careful surfactant selection
• Reduces blushing

✓ Specialty markets require specialty products

EXP 294

Solids by weight: 40% (± 1%)
Viscosity, 23 °C: < 500 mPa.s (Brookfield, Spin # 2)
pH value: 8.0 – 9.0
MFFT: +12 °C
Avg. Particle Size: 80 nm
Starting Formulations - Study

**Formula: EXP 294 EXP CS2**  
Clear Wet-Look Sealer / Stain Base for Concrete - 30 g/l VOC

Add in order with good agitation:

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXP 294</td>
<td>74.63</td>
</tr>
<tr>
<td>DIW</td>
<td>21.17</td>
</tr>
<tr>
<td>BYK348</td>
<td>0.35</td>
</tr>
<tr>
<td>BYK024</td>
<td>0.35</td>
</tr>
<tr>
<td>NH3 (25%)</td>
<td>0.35</td>
</tr>
<tr>
<td>Mergal K20 (20%)</td>
<td>0.35</td>
</tr>
<tr>
<td>Texanol</td>
<td>1.73</td>
</tr>
<tr>
<td>Propylene glycol</td>
<td>1.07</td>
</tr>
</tbody>
</table>

**Total** 100.00

- **Weight Solids (%)**: 30.6
- **Volume Solids (%)**: 28.0
- **VOC (g/L)**: <30
- **Density (g/L)**: 1037
- **Viscosity (cP)**: 10 – 15
- **pH**: 8.5 – 9.5

**Recommended Application Method**

Brush, Roller & Spray

---

**Recommended Application Method**

Brush, Roller & Spray

---

**Formula: EXP 294 FP1 Grey Floor Paint for Concrete – 35 g/l VOC**

Add in order with good agitation:

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIW</td>
<td>4.14</td>
</tr>
<tr>
<td>Tamol 731 N</td>
<td>0.69</td>
</tr>
<tr>
<td>Triton CF-10</td>
<td>0.30</td>
</tr>
<tr>
<td>Drewplus L-475</td>
<td>0.10</td>
</tr>
<tr>
<td>R902</td>
<td>7.38</td>
</tr>
<tr>
<td>Minex 7</td>
<td>14.75</td>
</tr>
<tr>
<td>Attagel 50</td>
<td>0.20</td>
</tr>
<tr>
<td>Grind</td>
<td>54.40</td>
</tr>
<tr>
<td>Mergal K20</td>
<td>0.49</td>
</tr>
<tr>
<td>NH3(25%)</td>
<td>0.10</td>
</tr>
<tr>
<td>Propylene glycol</td>
<td>0.92</td>
</tr>
<tr>
<td>DIW</td>
<td>11.89</td>
</tr>
<tr>
<td>Texanol</td>
<td>2.17</td>
</tr>
<tr>
<td>Drewplus L-475</td>
<td>0.20</td>
</tr>
<tr>
<td>Acrysol RM-825</td>
<td>0.20</td>
</tr>
<tr>
<td>Acrysol RM-2020</td>
<td>0.79</td>
</tr>
<tr>
<td>CCA 2491 Black Colorant</td>
<td>0.79</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100.00</td>
</tr>
</tbody>
</table>

- **Weight Solids (%)**: 48.0
- **Volume Solids (%)**: 36.7
- **VOC (g/L)**: <35
- **Density (g/L)**: 1221
- **Viscosity (cP)**: 60 – 70
- **pH**: 8.5 – 9.5
- **Gloss (60°)**: 10-15

**Recommended Application Method**

Brush & Roller
1. Delamination by Standing Water (CS2 - Wet Adhesion on Glass)

Apply + 4 hours, re-coat + 4 hours. 16 hours water soak. After recovery

After 16 hours Water Soak

- Commercial Sealer A
- Commercial Sealer B
- Commercial Sealer C
- Commercial Sealer D
- EXP 294 - CS2

✓ little/ no blushing, blistering, or loss of adhesion
1. Delamination by Standing Water (CS2 - Wet Adhesion on Glass)

Apply + 4 hours, re-coat + 4 hours. 16 hours water soak. After recovery

After 16 hours Water Soak & Cross-Hatch Tape Adhesion

Cross-hatch / tape adhesion test
1. Delamination by Standing Water (Wet Adhesion on Quarry Tile)

Over red floor tile – 2 hour water soak

- Commercial - Wet Look Sealer
- EXP 294 – CS2 Sealer

☑ Good adhesion on various cementitious substrates
1. Delamination by Standing Water (FP1 Garage Floor Paints)

Applied over glass – overnight water soak – tape adhesion

Cross-Hatch Tape Adhesion Test
Directly Over Black Glass
(No Primer)

EXP 294 @ <35 g/l  Commercial @ 150 g/l  Commercial @ 50 g/l

- Low VOC paint (1-2 % Texanol)
- Excellent adhesion in formulated paint
1. Delamination by Standing Water (other commercial products)

Four-hour cure, overnight water soak, cross hatch adhesion (dry/wet)

✔ EXP 294 – FP1 (left draw down)
1. Delamination by Standing Water – Exterior

Commercial GF Paints

EXP 294 FP1 Paint

Commercial GF Paints

Formulation (EPS®293 FP1)

After 12 months of truck traffic and water ponding

- Exterior durability
- Exposed to standing water (pond)
2. Hot Tyre Pick-Up (causes)

• Existing Surface
  - Previous coating
  - Grease, dirt
  - Smooth, low porosity substrate
  - Residue from acid etching

• Excessive sticking of tyre to coating (high performance tyres)

• Adhesion disruption of coating to substrate by water
  - Via penetration from surface (standing water)
  - Via water from below (hydrostatic pressure)
2. Hot Tyre Pick-up Lab. Tests - Pigmented Garage Floor Paints

Lab. Testing
- Coating dried for 7 days at RT.
- Heat car tyre to 50 °C in hot water.
- Place tyre and coated substrate in a carver press and apply 2 N/mm² for 2 hours.
- Repeat above with increasing press times until coating failure 2, 4, 6, 8, 12 hours.

Garage Floor Simulation
- Painted floor sections
- Park a car on it every day (drive on/ off)
- Variation in cars & tyres used

✓ Adhesion loss mimics the pattern of the tyre tread
✓ Good correlation (Test Garage)
2. Hot Tyre Pick-up Lab. Tests - Pigmented Garage Floor Coatings

- <4 hour in lab test. fail test garage in less than 12 months
- EXP 294 no issues under normal daily use in a garage – 12 months data (so far)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Time to Failure (hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2*</td>
</tr>
<tr>
<td>B</td>
<td>2*</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
</tr>
<tr>
<td>F</td>
<td>2*</td>
</tr>
<tr>
<td>EXP 294 - FP1</td>
<td>8</td>
</tr>
</tbody>
</table>

Note: * Fail dry test garage within 12 months
3. Staining from Tyres and Dirt

- Discoloration caused by:
  - Carbon transfer from the tyre to the coating
  - Oils and plasticizers migrating from the tyre to the coating
  - Oils may darken over time
  - Dirt embedding into the surface of the coating
3. Dirt Resistance – Lab. Screening (ROx Slurry – 24 hour)

EXP 294 @ <35 g/L       Commercial @ 50 g/L

- Coating dried for 7 days at RT.
- After 10 mins, the material is rinsed off.

✓ Very good dirt resistance at low VOC
3. Field Study - Carbon and Dirt Transfer

EXP 294 shows less dirt pick-up / staining vs. all other commercial 1K w/b paints
3. Cleaning - Pressure Washer Testing

After Attempted Removal by Pressure Washing

<table>
<thead>
<tr>
<th>Commercial GF Paints</th>
<th>EPS 293 FP1 GF Paint</th>
<th>EXP 294 FP1 GF Paint</th>
<th>Commercial GF Paint</th>
<th>EPS Higher VOC</th>
</tr>
</thead>
</table>

✔ excellent adhesion/erosion resistance
4. Discoloration, softening and delamination from Chemicals

- Prolonged exposure to chemicals may:
  - Stain the coating
  - Cause the coating to soften
  - Which may cause a change in gloss or may increase dirt pick-up
- Cause the coating to blister/ de-bond
## 4. Garage Chemicals - Resistance

<table>
<thead>
<tr>
<th>Chemical</th>
<th>1 Day on Mylar</th>
<th>3 Days on Mylar</th>
<th>7 Days on Mylar</th>
<th>7 Days on Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% KOH</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>TSP/H2O</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>10% Acetic Acid</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>5% Sodium Phosphate</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Floor Cleaner</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>5% HCL</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Bleach and Water</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Lysol Daily Shower</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Windex</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>The Works Cleaner</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>G3 Janitorial Glass Cleaner</td>
<td>8</td>
<td>10</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>95 Janitorial Sink Cleaner</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Windex Multi Surface</td>
<td>6</td>
<td>6</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Denatured Alcohol</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>409</td>
<td>0</td>
<td>3</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Unleaded Gasoline</td>
<td>6</td>
<td>6</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Power Steering Fluid</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Motor Oil</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Brake Fluid</td>
<td>1</td>
<td>3</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Transmission Fluid</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>5% Salt Solution</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Antifreeze/Water 50:50</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

24 h spot test (10 is the best)

- Very good chemical resistance on concrete after 7 days drying
Conclusions

Next Gen. Resin for Garage Floor Paints “EXP 294”

✓ 1K Acrylic
✓ Application – brush, roller or spray
✓ Excellent re-coatability after short drying periods.
✓ Eco-label 2015 – Formulation Capable
✓ Low VOC capability (< 35 g/l)
✓ ADH Free x-linker technology
✓ Excellent adhesion – wet & dry
✓ Excellent clarity in clears & very low blush
✓ Excellent chemical resistance
✓ Suitable to apply on “green” concrete
Thanks for your attention

Come visit us at Stand 356 in Hall 7 to find out more......

Note: EXP 294 is now commercially available (sold under EPS® 294) and samples / starting formulations