UV Light Degradation of Fly Ash Loaded Polyurethane for External Applications

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Introduction:

Polyurethanes (PUR) have many purposes: cushioning, shoe soles, artificial heart valves, electrical equipment and external applications. This project involves studying the effect of several stressors on the degradation of PUR including heat, light and moisture.

PUR samples were loaded with Fly Ash to increase strength and durability and degradation effects of sunlight were tested.

Weathering

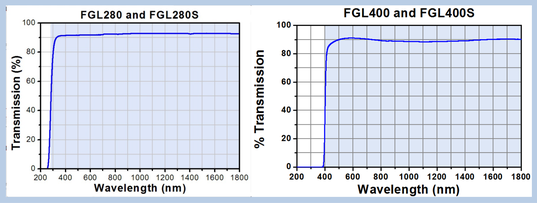
Accelerated Weathering Chamber

- Reproduces damage caused by full-spectrum sunlight and rain
- 2-hour cycles with 2 steps
  1. 102 mins: light, humidity = 35%, temp = 63 °C
  2. 18 mins: light, spray, humidity = 35%, temp uncontrolled
- Total 11 steps, 1 step ~ 48 Hours

Q-Sun Accelerated Weathering Chamber

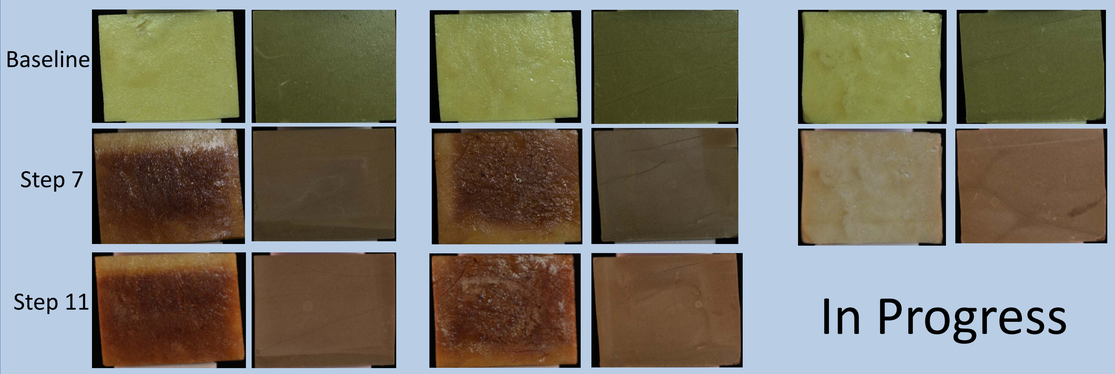
UV Filters

- Quartz >280 nm Filter
- Longpass > 400 nm Filter



Fly Ash

- Industrial Waste from Coal Production
- 1 Ton = Energy for One Home for 24 Days
- DOE Support: "Positive environmental effects include…reduced solid waste, reduced use of natural resources, reduced energy consumption"



Color Analysis

Delta E

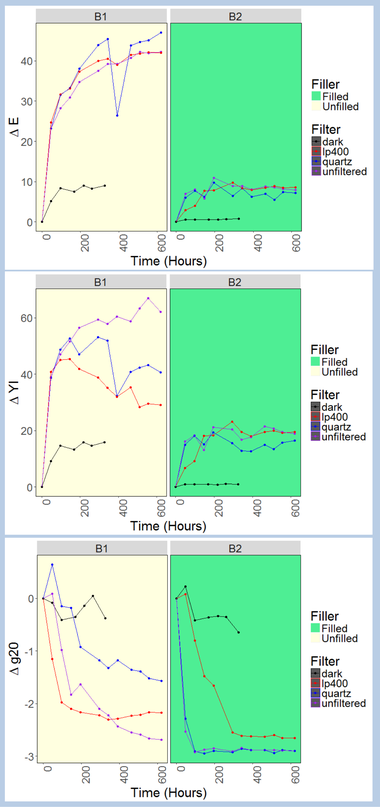
- Removal of all light results in significantly less change in color
- Filled: suggests less degradation due to fly ash filler, also light sensitive

Delta YI

- Removal of light shows significantly less increase in YI
- Less change in lp400 – degradation partially caused by UV spectrum
- Steady YI after a point in all samples
- Filled samples have less change, suggests filler mitigates yellowing

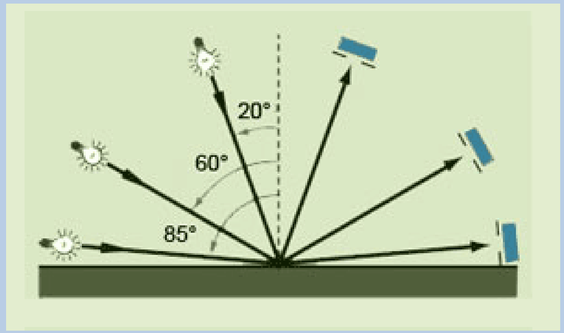
Delta Gloss 20 Degrees

- Removal of all light shows steadiness in gloss
- Gloss loss in B1 mitigated by quartz filter, passes UV light, blocks moisture
- B2 Samples show gloss loss reduced with longpass 400 nm filter



Characterization

- Yellowness Index (YI)
  1. Increases with light, chemical exposure and processing
- Hue (E)
  1. Combination of a* (red/green), b* (blue/yellow), l* (lightness)
  2. Color loss depends on **amount UV Radiation**, pigment variations
- Gloss
  1. Quality of surface reflecting light
  2. Decreases as material degrades
  3. Decreases as surface roughens



Conclusions/Future Work

- Weight of samples did not change significantly
- Removing all light significantly mitigated change in color and samples yellowing
- Removing UV light slightly reduced yellowing
- Interaction of light with sample needs further exploration beyond the UV light
  - Expose samples to more specific regions of light
- FTIR analysis to show chemical degradation
- Replicate samples to account for sample variation

Acknowledgements:

Funding: SURES, Case Alumni Association, SDLE
Solar Durability and Lifetime Extension (SDLE) Center
Laura S. Bruckman
Roger H. French
MORE Center
Ina T. Martin
Saint-Gobain International