

**Recent research by Polymer Aging Concepts, Inc. in cooperation with Georgia Tech shows that simple, low-cost electrical resistivity measurements predict remaining life of rubber and plastic products.**

Research conducted on EPR, Silicone Rubber (SR), and XLPE, combined with nano particles of carbon black filler showed a dramatic decrease in electrical resistivity as the polymer aged. When the electrical resistivity data was used in an Arrhenius plot, it actually predicted the remaining life of the product.

Low-cost carbon black particles, embedded in the rubber or plastic (or a minute portion of the material), function as a sensor to track minute changes in the product as it ages. Consequently, the sensor monitors the actual state of the material itself rather than modeling the changes that *may* be taking place based on input from environmental sensors in the area.

Extensive research in cooperation with Georgia Tech indicates that the sensor (called AgeAlert) accurately monitors the degradation state and predicts remaining life for EPR, silicone rubber and XLPE.

Additionally, initial research indicates that the AgeAlert technology will monitor the condition of virtually any degradable product.



Research conducted at Georgia Tech and Polymer Aging Concepts, Inc. indicates that the patent-pending AgeAlert technology offers very useful, non-destructive condition monitoring. Research further indicates that the AgeAlert technology should be able to monitor the state of virtually any degradable product.

## Features and Benefits

The benefits of the patent-pending AgeAlert technology include:

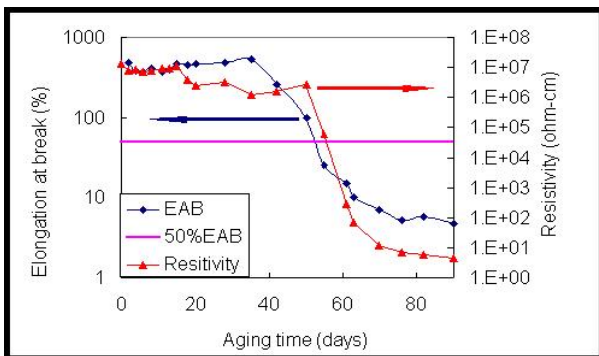
- Improved safety and reduced costs from premature failures or shutdowns. AgeAlert accurately monitors the degradation of the product from *actual* use and storage conditions, allowing replacement before failure of the product.
- Easy to use. AgeAlert provides *objective* results (good/bad, percentage degraded, *or* remaining life).
- Product flexibility. Multiple methods of product-sensor integration and sensor communication allow use with a wide range of rubber and plastic products.
- Compatible with passive RFIDs. Simple resistance output requires no batteries and provides "life cycle" product identification *and* status.
- Low cost sensor. Use of low-cost carbon black and the actual rubber or plastic material as the sensor results in low sensor costs as compared to time-temperature integrators.

# AgeAlert Technology Update for Rubber and Plastic Products

## How AgeAlert Works

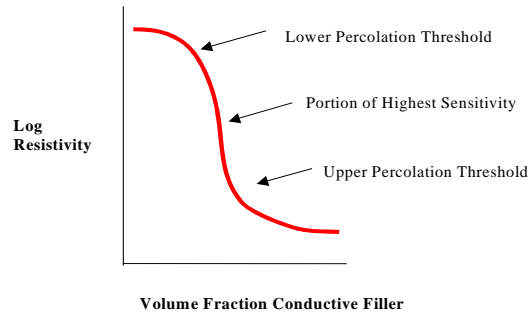
AgeAlert™, a low-cost conductive composite sensor, precisely measures the degradation state of virtually any degradable product. As the product ages, the polymeric components of the product shrink very slightly. At the same time, the polymeric components of the AgeAlert™ sensor also shrink, precisely mimicking the changes in the product.

AgeAlert™ essentially tracks the very minute change in shrinkage through change in electrical resistivity. For example, as a polymer ages, AgeAlert™ monitors how much the product has aged by monitoring the electrical resistivity in the sensor.

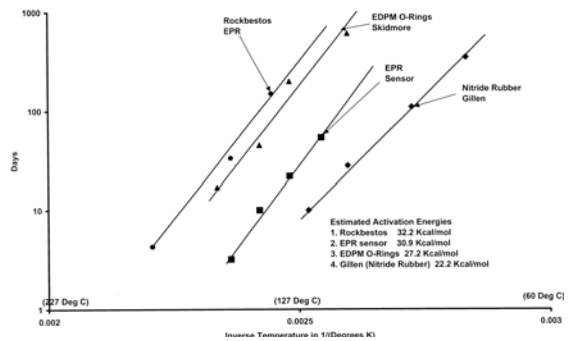


As aging occurs, the resistivity of composite structures correlates strongly with mechanical properties such as elongation at break. (Research conducted by GA Tech and Polymer Aging Concepts, Inc.)

## Percolation Curve for Age Sensor



Minute changes in product polymer shrinkage during aging provide large changes in resistance output of the sensor.



By using the Arrhenius equation, the change in electrical resistivity predicts remaining life of the polymer material.

## AgeAlert sensor communications can take many forms:

1. Sensor strip integrated into the component can connect directly to a terminal box/reader;
2. Sensor particles embedded into outer layer of piping or tubing can be queried using a contact reader (see simulated photos of hose and tire below);
3. Combined AgeAlert sensor / RFID tag can integrate into the component; or the RFID tag can mount onto the piping or tubing. The passive RFID tag communicates with remote (wireless) RFID reader.



Sensor particles embedded in outer layer of product can be queried by low-cost, contact reader. (Note: hose and tire photos simulated for illustration only)

AgeAlert Sensor / RFID Tag