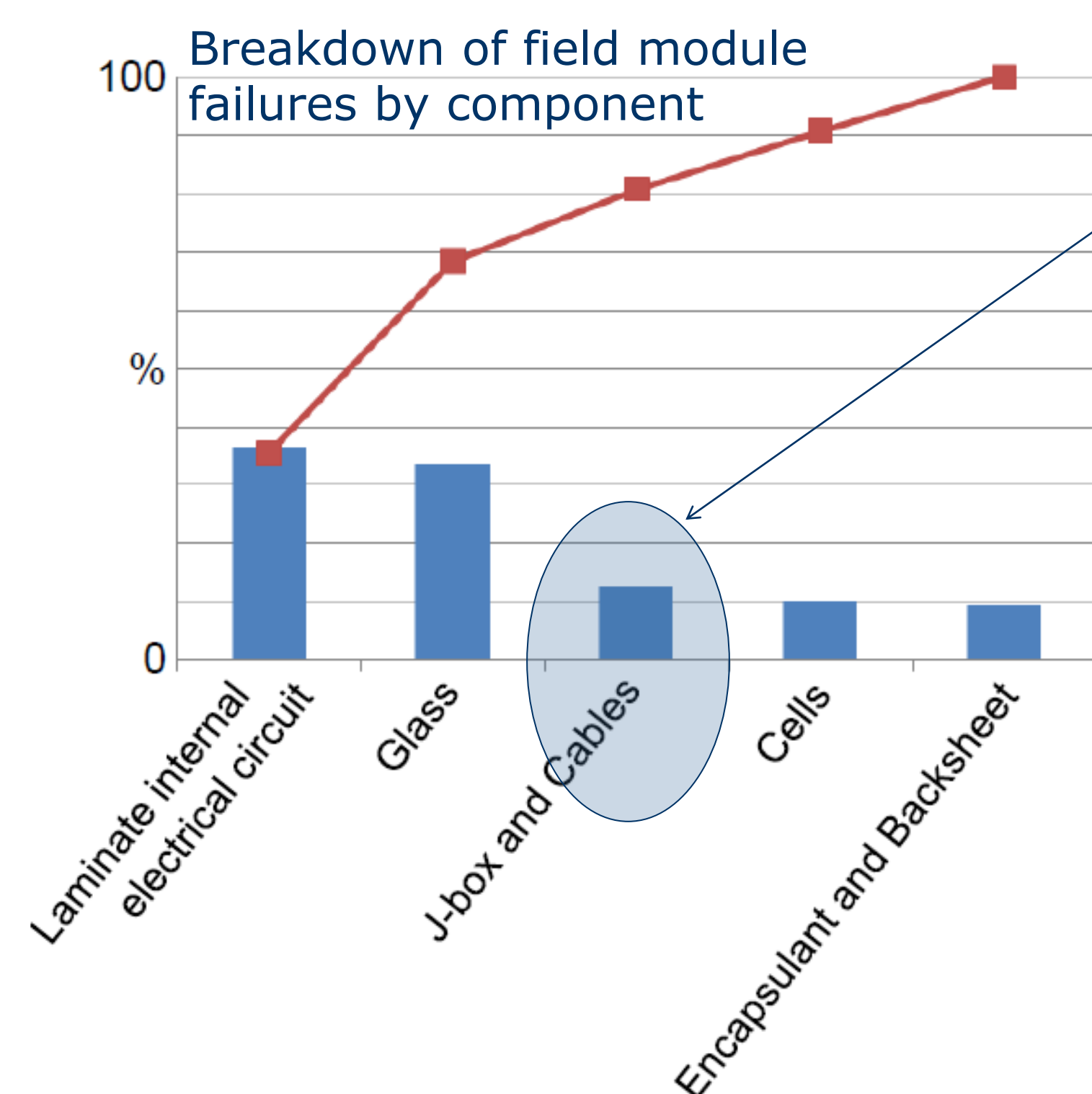


Improved Plastic Materials for Application in PV Modules

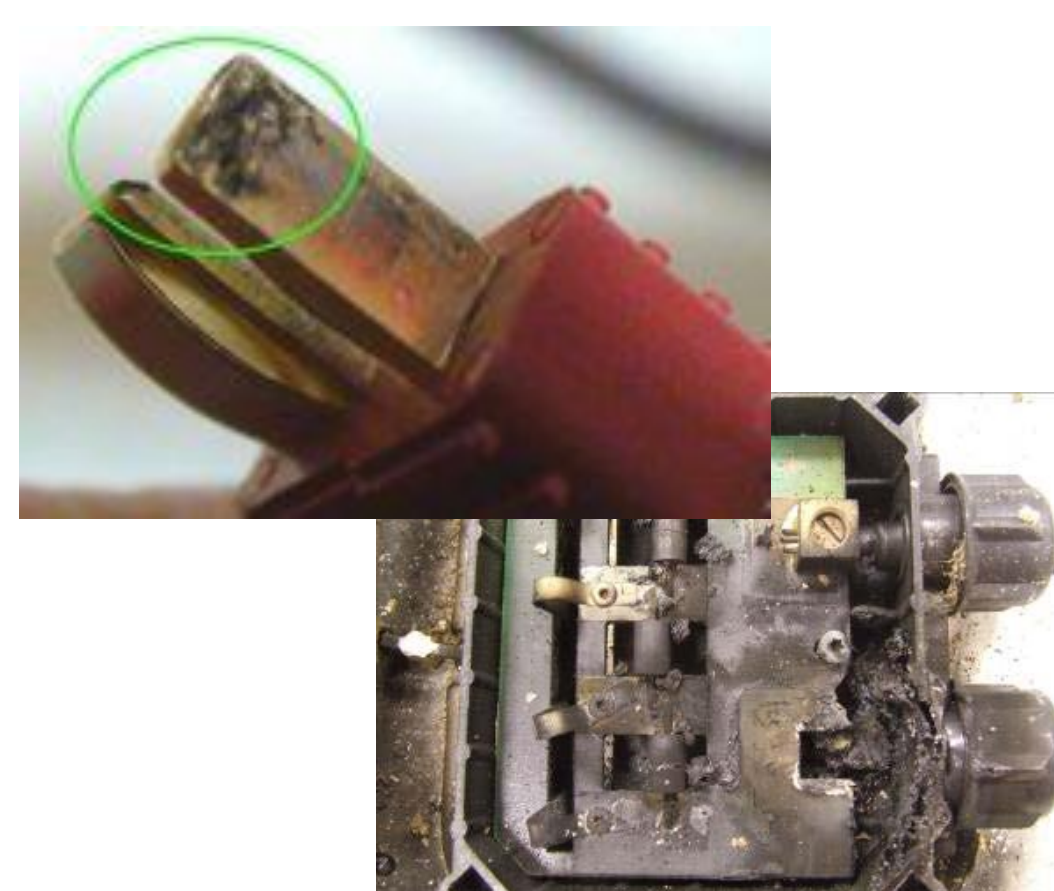


Reliability of J-Box and Connector Materials

Importance of Connectors and Junction Boxes in PV Module Reliability



Junction boxes, cables and connectors are the source of 12% of module failures



Data shows % failure of non-SunPower modules over 7 year timescale. From David DeGraaff, Ryan Lacerda, Zach Campeau (SunPower Corp), NREL 2011 PV Module Reliability Workshop, Golden, CO

Stressors on Plastic Materials in PV

Operational stresses

- Impact during installation and maintenance
- High voltage



Environmental stresses

- Moisture
- Temperature
- UV

Failure-induced stresses

- Flames
- Electrical arcs



Critical Properties for Plastics in PV

- Impervious to environmental stresses
- Impact resistance at range of temperatures
- Flame and arc resistance
- No creep or embrittlement with aging

Experimental Methodology: Tests Performed on Material Samples

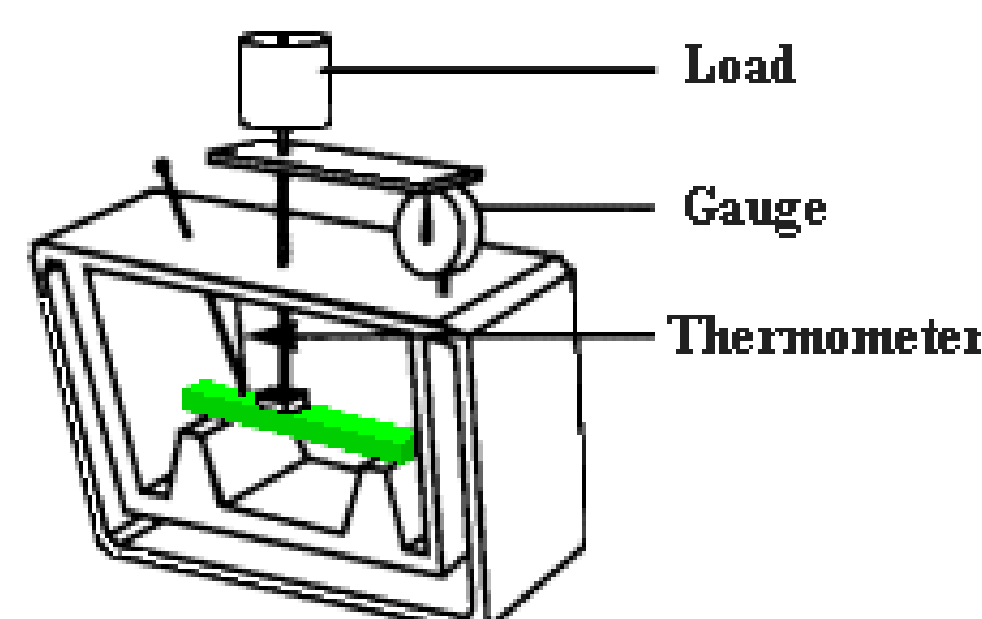
Impact resistance / embrittlement with aging

- Izod notched impact (INI) test (ISO 180) at -30 °C
- Ductility multi axial impact test (ISO 6603) at 0, 1000, 2000 and 3500 h of 85 °C 85 % RH



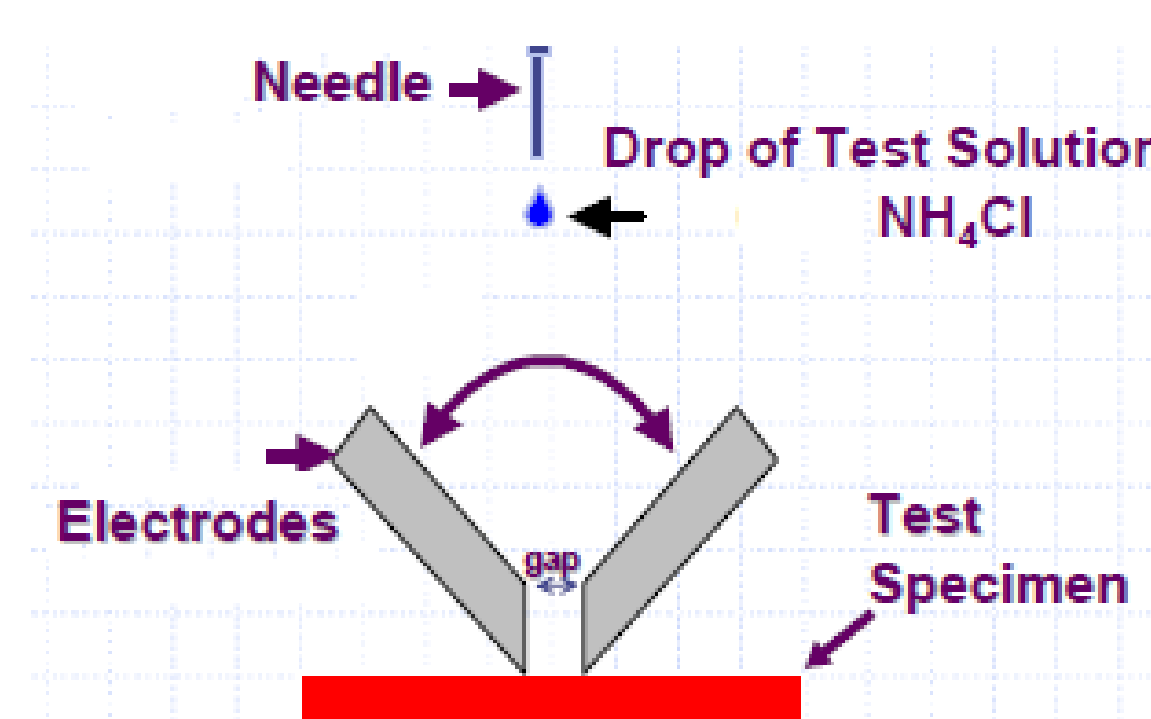
Thermal distortion

- Heat distortion temperature (HDT) test (ISO 75)
- Relative thermal index (RTI) impact test (UL 746)



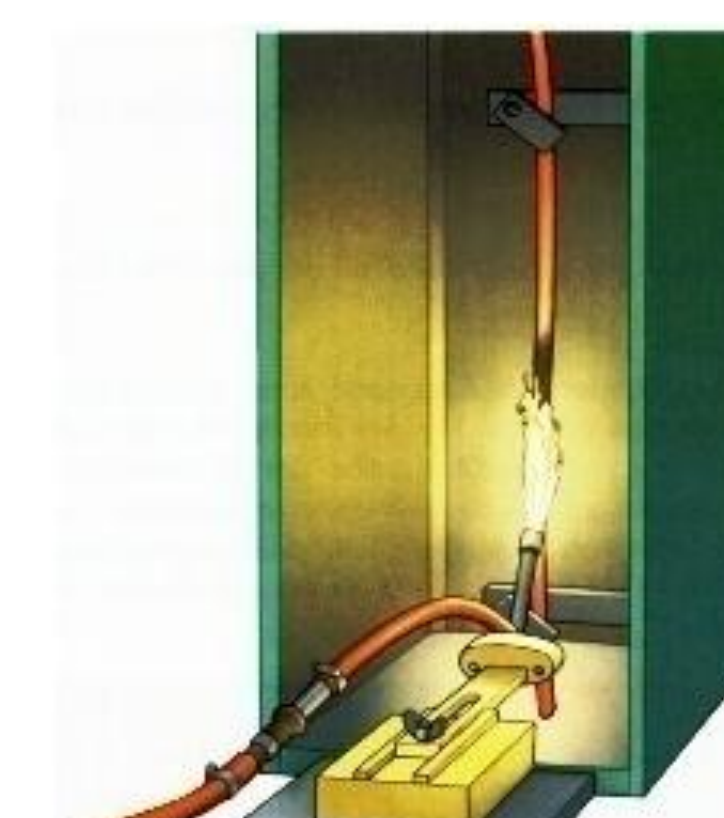
Arc resistance and formation of carbonized track

- Comparative tracking index (CTI, ASTM D3638)



Flammability:

- V-rating (for 0.8mm specimen, UL 94)
- Minimum thickness for V0 rating
- Minimum thickness for VA rating

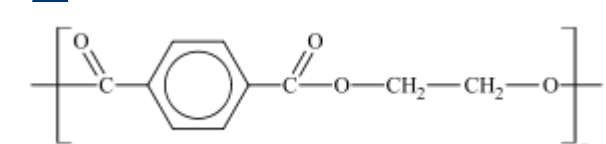


Materials Tested

The six most promising plastic materials were tested:

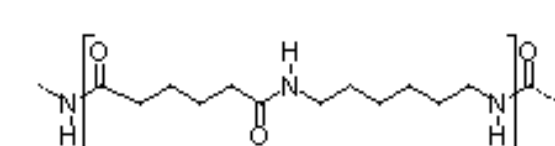
PET (polyethylene terephthalate)

- A flame retardant grade of glass filled PPE



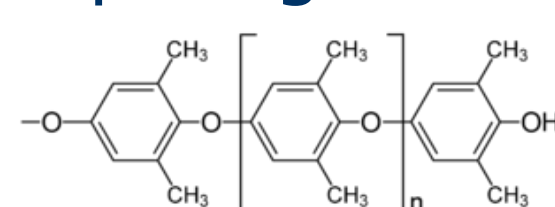
PA (polyamide)

- A flame retardant, glass filled grade of nylon



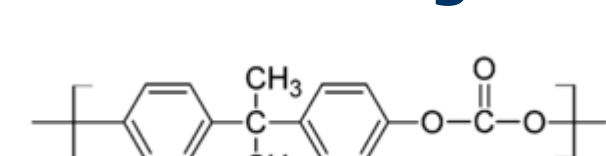
PPE (poly phenylene ether)

- A high impact grade of PPE



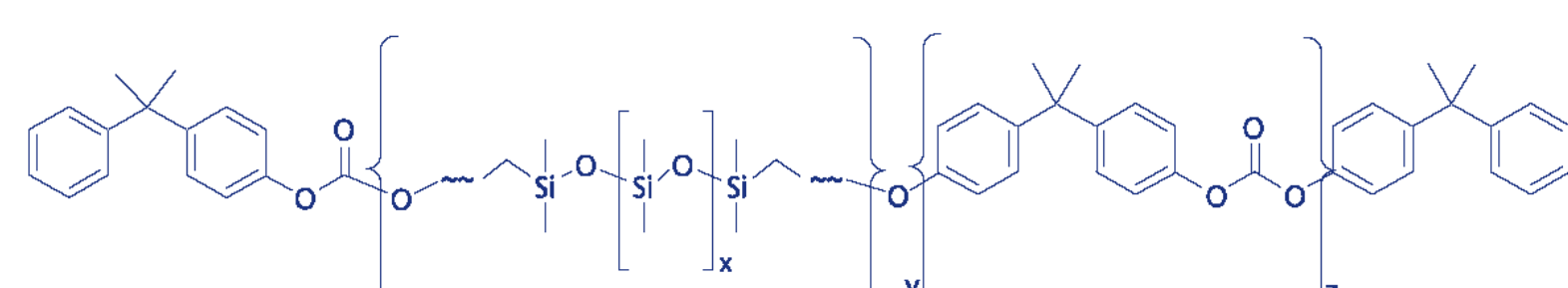
PC (polycarbonate)

- A flame-retardant grade of PC



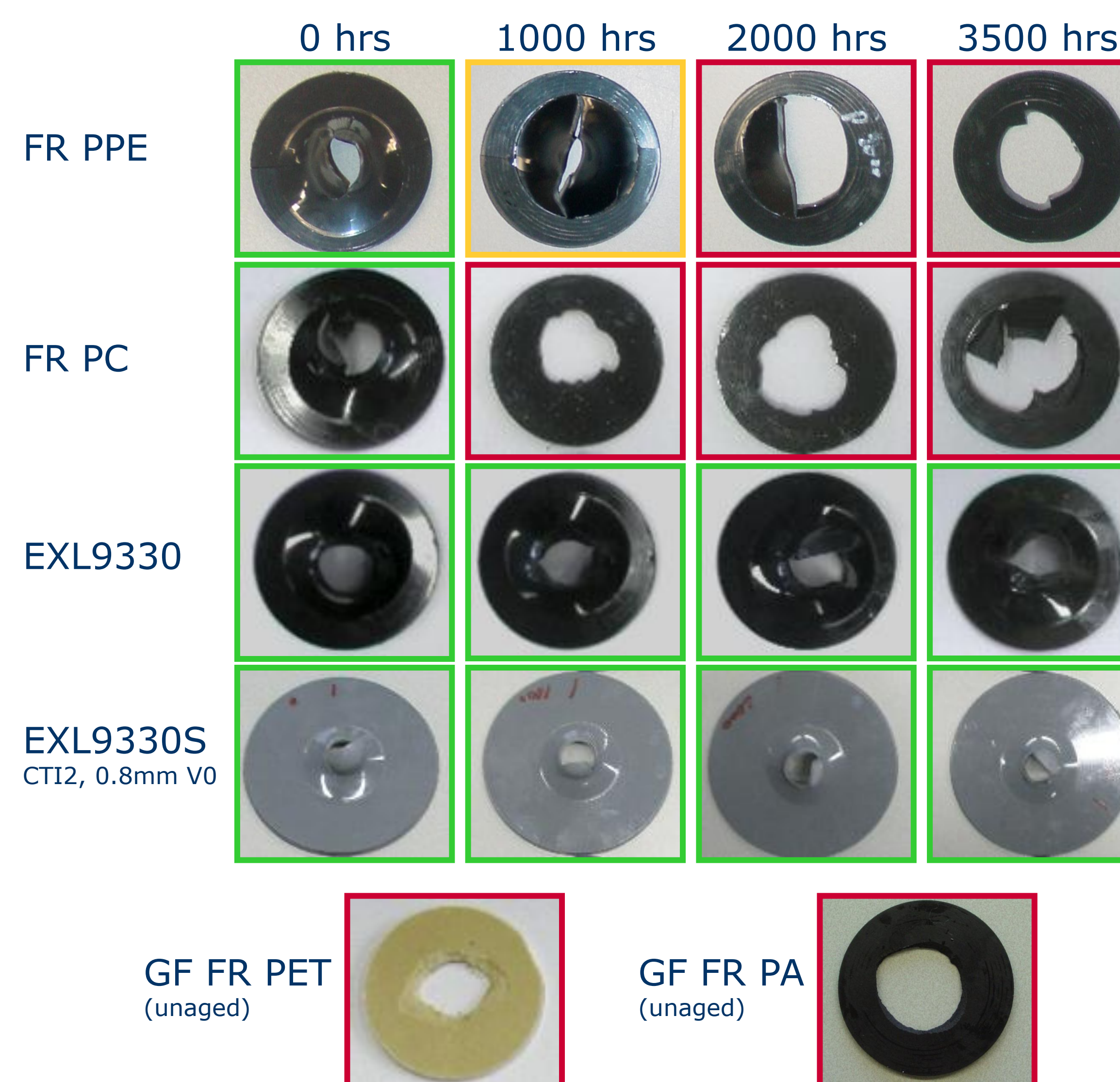
PC / silicone copolymer

- Lexan* EXL9330
- Lexan* EXL9330S



Results

Damp Heat testing at 85°C and 85% rel humidity



GF FR PET (unaged)



GF FR PA (unaged)



Polycarbonate/silicone copolymers provided the best overall reliability

* Trademark of SABIC Innovative Plastics IP BV

Karin van de Wetering, Robert van de Grampel, Richard Lucas, Jaykisor Pal, Anil Ks, Dan M.J. Doble, Andrew Kodis, Bala Ambravan, Rob deJong, Dirk Noordegraaf

CHEMISTRY THAT MATTERS™