Solar Edge Sealants with a Better Balance of Properties

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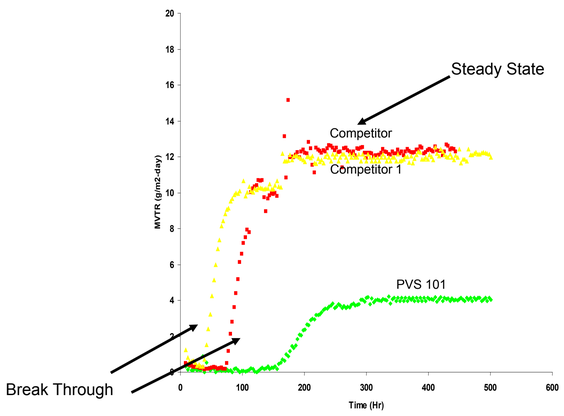
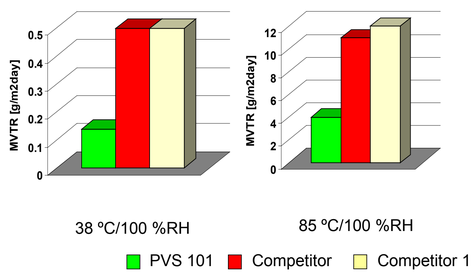
INTRODUCTION

Photovoltaic (PV) modules demand solar edge sealants with a better balance of surface (tack and reactivity) and bulk (thermal, mechanical, and barrier) properties. The major objective of this research was to develop solar edge sealants that chemically react with glass and show better thermal stability, mechanical properties, and moisture vapor transmission resistance (MVTR). The glass – edge sealant chemical adhesion was characterized using lap shear testing. Thermal stability was characterized using gravimetric method and mechanical properties were characterized using tensile testing. MVTR was measured using MOCON.

WATER INGRESS



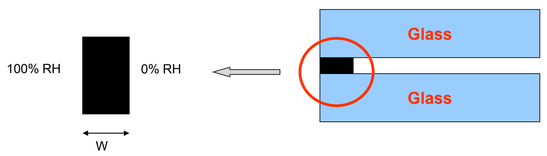
Sample spectra at 85 ºC and 100% RH



MOCON Method
Surface Area: 38 ºC: 50 cm²
85 ºC: 20 cm²
Thickness: 0.060 - 0.080 inch

Longer break-through time and lower steady state MVTR for PVS 101.

FICKIAN 1-D DIFFUSION MODEL



Boundary Conditions

at X = 0; $C_w = C_s$
at X = W; $C_w = 0$

Fickian 1-D Diffusion Model

MVTR = D (dc/dx)
MVTR = D (Cs/W)

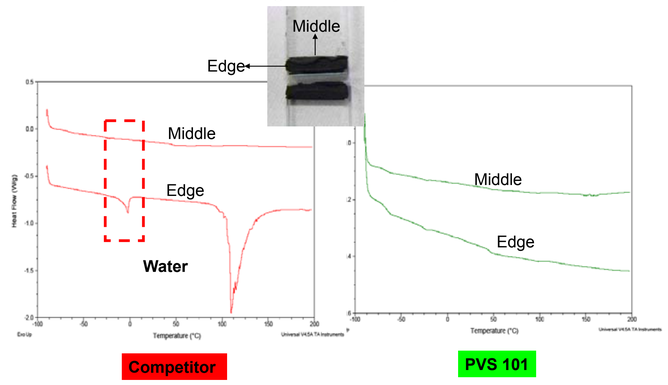
MOCON PVS 101 ⇒ **Steady state 38 ºC diffusivity for PVS 101 = 5.6E-7 cm²/sec**

MOCON Competitor ⇒ **Steady state 38 ºC diffusivity for competitor = 2.0E-6 cm²/sec**

~42% reduction in width will theoretically match performance of competition assuming a linear relationship in temperature. We recommend 25% as a conservative buffer.

DSC: MOISTURE INGRESS CHARACTERIZATION

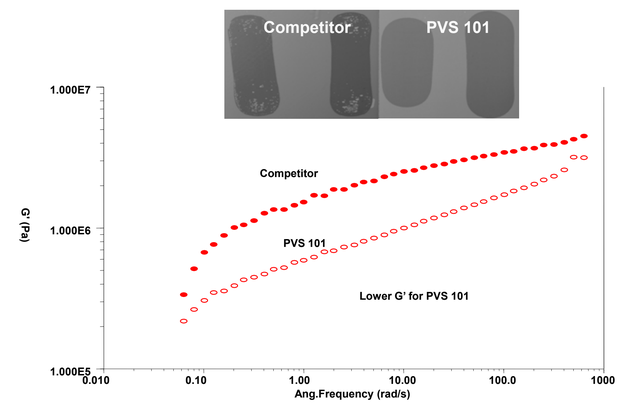
Lap shear samples, aged 4 weeks in a damp heat chamber
DSC: Differential Scanning Calorimetry



Longer break-through time for PVS 101.
Differential Scanning Calorimetry verified MOCON results.

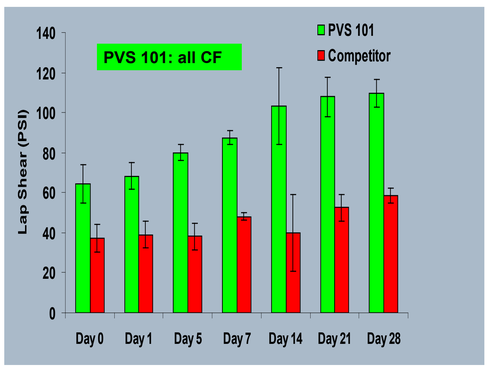
RHEOLOGY: WET OUT

Small Amplitude Oscillatory Stress Experiment: 100 Pa Shear Stress using 8mm diameter plates at 80 ºC

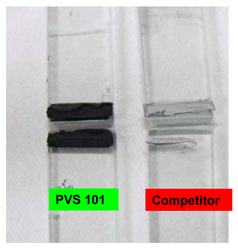


PVS 101 rheology has been engineered to exhibit improved wet out.

ADHESION TO GLASS



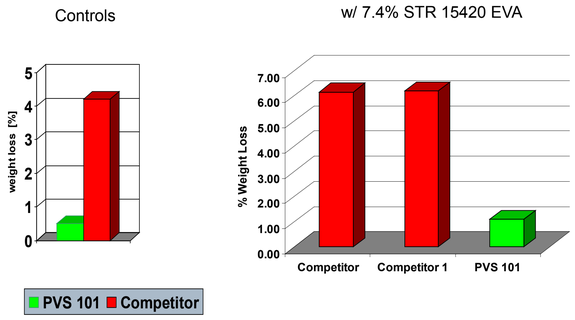
CF = Cohesive Failure



PVS 101 rheology and surface properties have been tuned to result in cohesive failures.

PVS 101 – EVA COMPATIBILITY

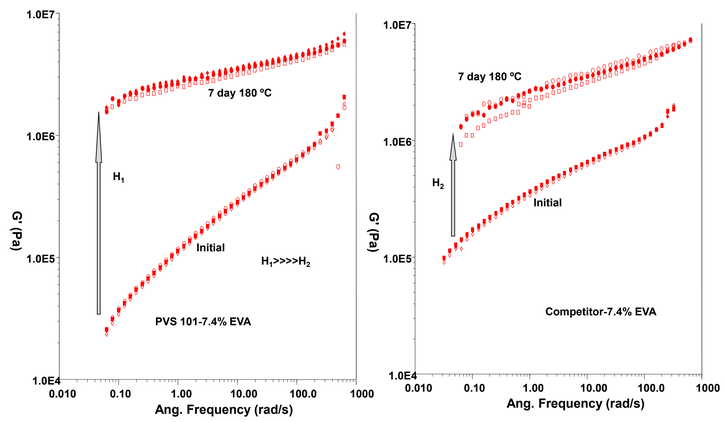
% weight loss upon 180 ºC air circulated oven treatment for 72 h



PVS 101 exhibited superior thermo-oxidative stability by itself as well as in the presence of fast cure EVA.

RHEOLOGY: PVS 101 – EVA COMPATIBILITY

Small Amplitude Oscillatory Stress Experiment: 100 Pa Shear Stress using 8mm diameter plates at 80 ºC



PVS 101 showed a greater potential to crosslink when exposed to EVA at 180 ºC.

CONCLUSIONS

- PVS 101 has been designed to exhibit a superior MVTR as characterized using MOCON and DSC
- PVS 101 binds chemically with glass and the bonding strength increases with time
- PVS 101 rheology has been engineered to exhibit improved wet out
- Superior compatibility with EVA

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