Thermally-induced healing of electrically-insulating ethylene-octene copolymers

Scott R. Zavada,[*†] *Godfrey Sauti,*[‡] *Keith L. Gordon,*[‡] *Joseph G. Smith,*[‡] *Emilie J. Siochi*[*‡]

[†]National Institute of Aerospace, Hampton, VA 23666, United States

[‡]NASA Langley Research Center, Advanced Materials and Processing Branch, Hampton, VA 23681, United States

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Experimental

Thermogravimetric Analysis

Thermogravimetric Analysis (TGA) was performed by using a Netzsch TG 209 F1. Approximately 10 mg samples were heated in N_2 from 25 to 500 °C at 10 °C/minute.

Differential Scanning Calorimetry

Differential Scanning Calorimetry (DSC) was performed using a Netzsch DSC 204 F1. Approximately 4 mg. samples were heated from 25 to 105 °C at 25 °C/minute, cooled to -180°C at 25 °C/minute, and heated to 245 °C at 15°C/minute. The melting temperature (T_m) was taken as the endothermic melting peak minimum of the second heating run. The glass transition (T_g) temperature was reported as the temperature where the glass transition's endothermic baseline shift is changing most rapidly (i.e., the peak of the first derivative).

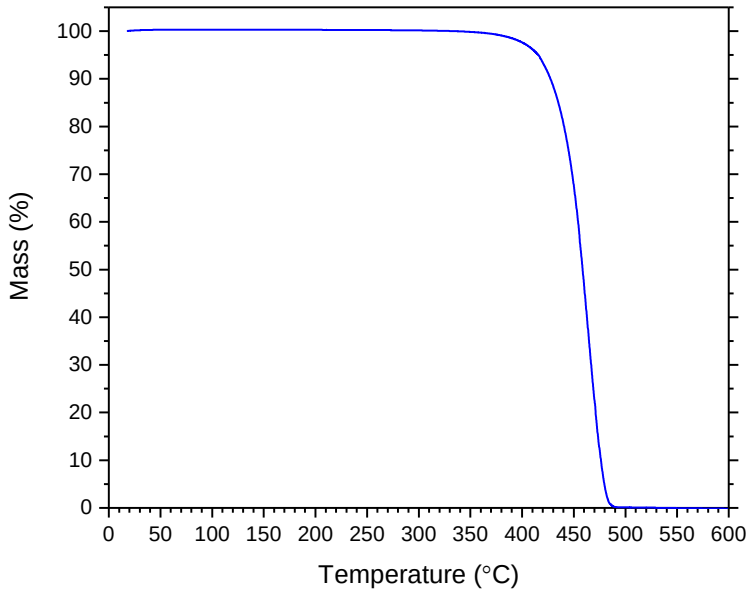


Figure S1: Thermogravimetric Analysis (TGA), performed at 10°C/min in N_2, of EOC.

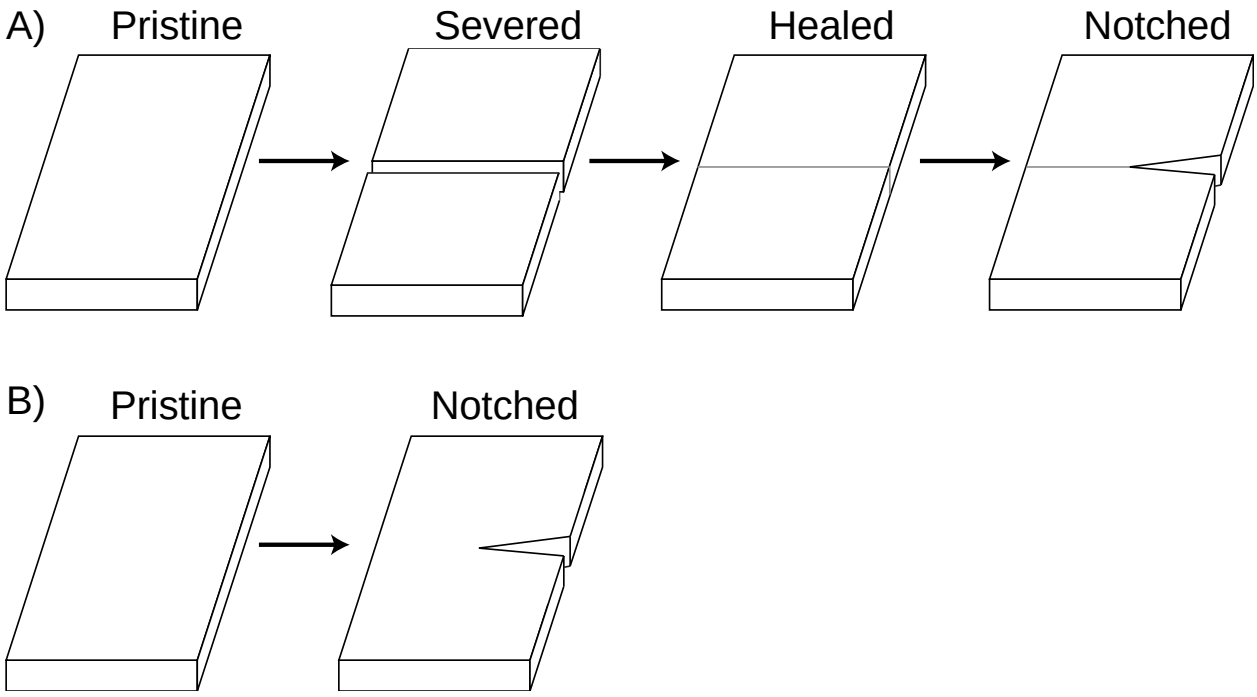


Figure S2: Method for preparing sample for the J-integral critical fracture energy: A) cut/healed and B) pristine samples.

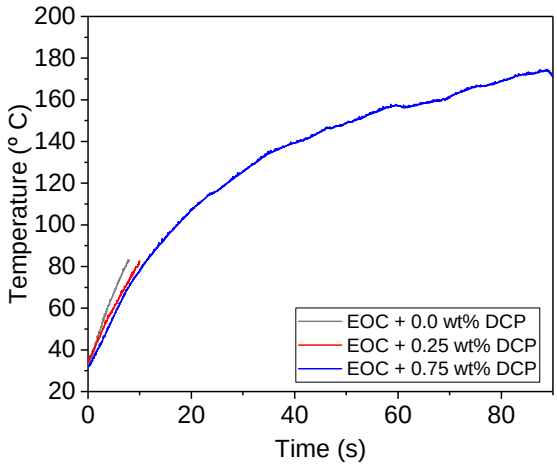


Figure S3: Temperature vs. time during the scratch-healing experiments. Healing was observed in the 0 and 0.25 wt% DCP formulations, while no healing was observed for 0.75 wt% DCP.

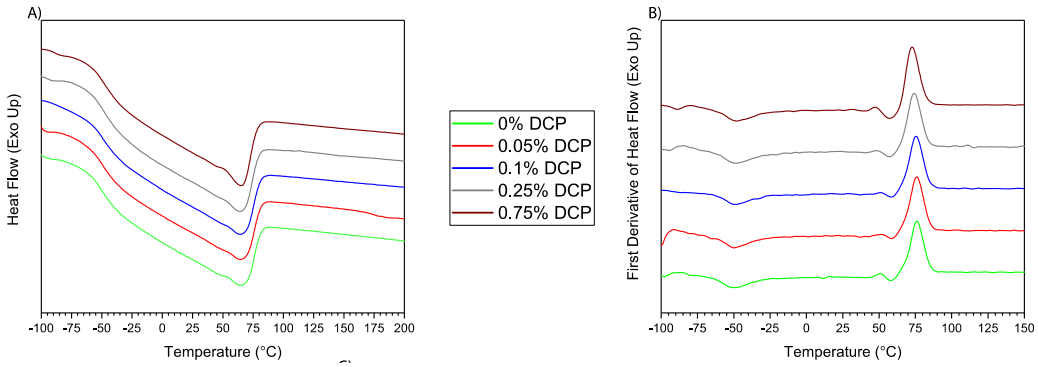


Figure S4: DSC thermograms for EOC formulations with 0, 0.05, 0.1, 0.25, and 0.75 wt% DCP. Depicted are the A) second heating curve and B) derivative of second heating curve.

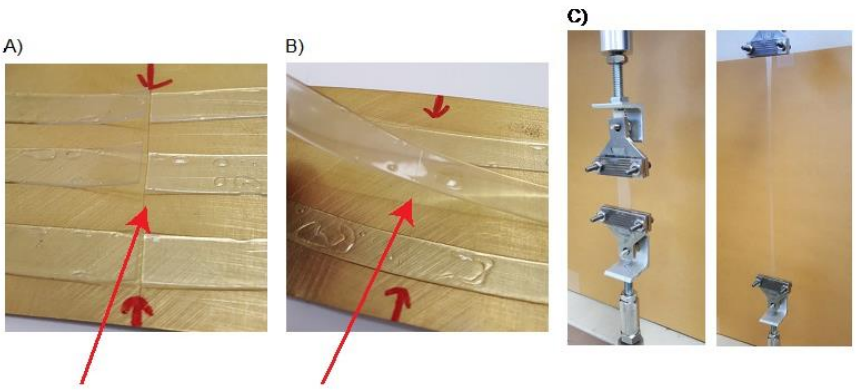
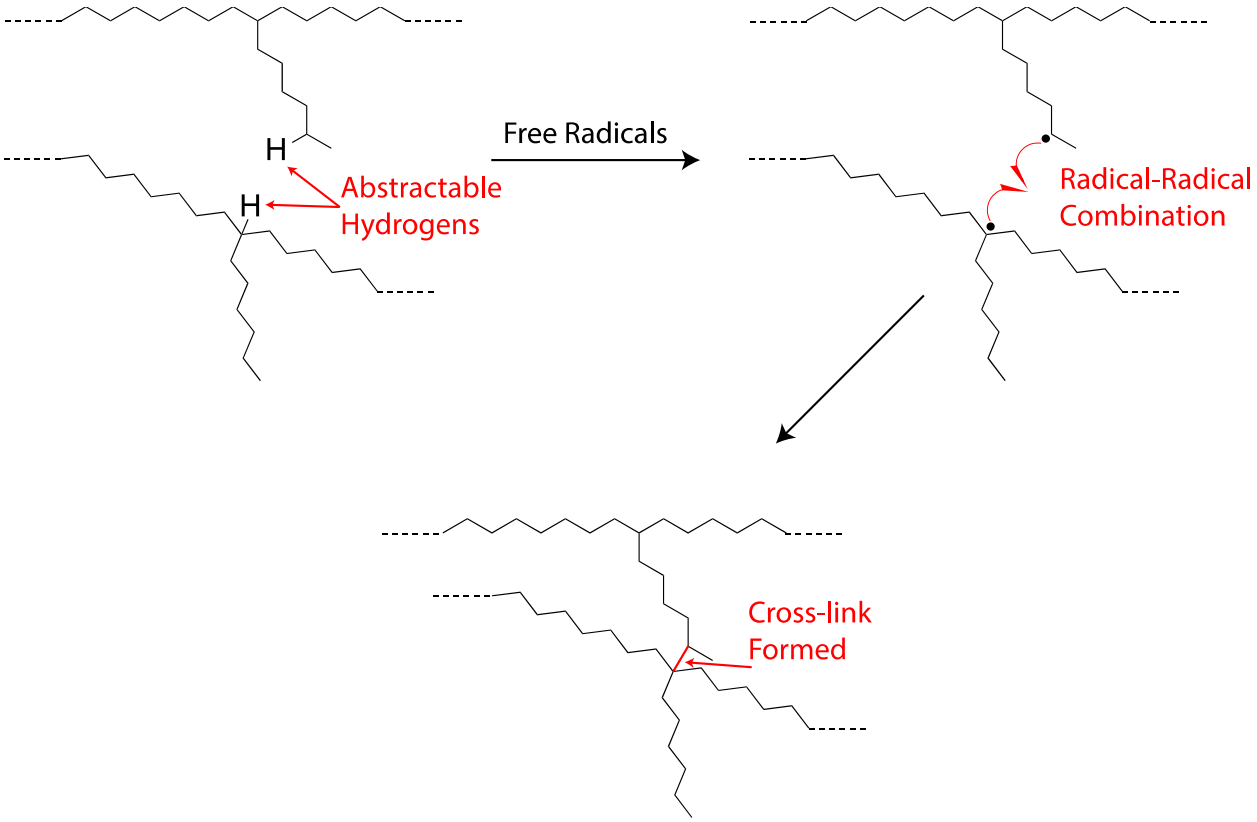


Figure S5: A) Unmodified EOC film was severed with a razor blade (red arrow shows where film was cut). B) After heating at 90 °C for 5 minutes, the two severed pieces underwent a repair processes, forming a single piece (red arrow shows the location of joint formed). C) A tensile test demonstrates that the healed material was able to stretch to eight times its original length.



Scheme S1: Free-radical mechanism for cross-linking EOC. The secondary and tertiary hydrogens can be abstracted by free radicals, yielding radicals on the polymer. These radicals can then undergo radical-radical combination reactions to form a cross-link.

Table S1: Time required for G′ to exceed G″ at various frequencies during a multiwave rheometry experiment. Dashes indicate no G′/G″ cross-over.

	Time to reach G′/ G″ cross-over (minutes)			
DCP (wt%)	0.1 Hz	0.5 Hz	1 Hz	5 Hz
0	—	—	—	—
0.05	—	—	—	—
0.1	—	—	—	10.7
0.25	11.3	10.3	9.8	9.3
0.75	8.7	8.2	8.2	7.7

Table S2: T_g and T_m values obtained from DSC data for EOC formulations with varying concentration of DCP.

Wt% DCP	T_g (°C)	T_m (°C)
0	-50	64
0.05	-50	64
0.1	-50	64
0.25	-48	64
0.75	-48	64

Table S3: Temperatures of the α and β transitions observed as loss modulus peaks in the DMA thermograms.

	Loss Modulus (E'')	
Wt% DCP	β (°C)	α (°C)
0	-50	73
0.05	-49	74
0.1	-49	74
0.25	-49	74
0.75	-49	80