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· TEST REPORT ·

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Akron Rubber Development Laboratory, Inc.
ARDL Engineering Department

miniDeMattia Testing for Ten Sheets

Prepared For:

Vicky Rebar
Xenolite
975 Madison Ave.
Norristown, Pa. 19403
Tel: 610-650-8690 ext 210
Email: Vicky@xenolitexray.com

Prepared By: _____
Jonathan Martens
Research Chemist

Approved By: Edward R Terrill
Edward R Terrill, Ph.D.
Applied Research Fellow

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SUBJECT:
miniDeMattia Testing for Ten Sheets

EXECUTIVE SUMMARY:
The purpose of this work was to characterize ten sheets (x-ray protection garment materials) using miniDeMattia flex tester. The work determined the onset of surface cracking, surface crack growth rate, and full rupture (hole formation).

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PURPOSE AND SCOPE:
The purpose of this work was to characterize ten sheets (x-ray protection garment materials) using miniDeMattia flex tester. The work determined the onset of surface cracking, surface crack growth rate, and full rupture (hole formation).

BACKGROUND:

This work is the fifth experiment (series of samples) tested by miniDemattia and it used the first method. We have used three different test methods. We were trying to improve the method (to help to see the cracks – first we added a device which allows us to push the specimen from behind; and secondly, painting the surface with silver pen). A summary of the methods and sample series are shown below in chronological sequence.

Method 1 - First Series (Samples 1 – 6)
Stretching device was not used.
Silver ink was not applied on the sample surface.

Method 2 - Second Series (Samples 7 – 10)
Stretching device was used.
Silver ink was applied on the sample surface.

Method 2 - Third Series (Samples 1 – 6)
Stretching device was used.
Silver ink was applied on the sample surface.

Method 3 -Fourth Series (Samples 7 – 10 and 3)
Stretching device was used.
Silver ink was not applied on the sample surface.

Method 1 - Fifth Series (Samples 1 – 10)
Stretching device was not used.
Silver ink was not applied on the sample surface.

Method 1 was determined to be the best. That means, both modifications have failed to improve the technique. For this reason, samples 1 to 10 were repeated using method 1.

EXPERIMENTAL TECHNIQUES:

Materials: The ten sheets are listed in Table 1 and were tested as received.

Table 1: List of Materials

ARDL NB#	Description
ERTNB6-100-1	Sample 1 – [redacted]
ERTNB6-100-2	Sample 2 – [redacted]
ERTNB6-100-3	Sample 3 – Lite Tech B3E 0.125 mm Pb (18 mil thick)
ERTNB6-100-4	Sample 4 – Lite Tech TBE 40 0.125mm Pb (20 mil thick)
ERTNB6-100-5	Sample 5 – Lite Tech TBE 36 0.125mm Pb (20 mil thick)
ERTNB6-100-6	Sample 6 – Lite Tech TBF 0.125mm Pb (16 mil thick)
ERTNB6-113-1	Sample 7 – Lite Tech TBE 33.3 0.125 mm Pb (20 mil thick)
ERTNB6-113-2	Sample 8 – Lite Tech NLE 0.175 mm Pb (25 mil thick)
ERTNB6-113-3	Sample 9 – [redacted]
ERTNB6-113-4	Sample 10 – [redacted]

miniDeMattia flex test:
In the interest of measuring fatigue properties of small samples extracted from engineered rubber components, ARDL, Inc. has developed the Mini DeMattia test. The nominal test specimen dimensions were 1.5" long by 0.125" wide by 0.020" to 0.030" thick. The test specimens were mounted on the Mini DeMattia frame. This instrument is capable of testing 100 samples simultaneously. It is driven at 5Hz using an electric motor attached to a steel cam to provide accurate displacement control and the sample crack lengths are measured using a vision system. Measurements were taken at specified intervals (1,000, 2,000, 5,000, 10,000, 20,000, 30,000, 50,000 cycles and then 50,000 cycles per interval after that). The surface crack lengths are reported as a percentage of the total sample width.

RESULTS:

The crack length results are summarized in Figures 1 to 10. The diamond, square, triangle and x-shaped data points (specimens 1 to 4) came from specimens taken in the machine directions and the asterisk, dot, plus and dash shaped data points (specimens 5 to 8) came from specimens taken in the cross direction. The results were compared in Figures 11-16. The results for samples 1 – 6 from this series were compared to the results for the same samples from the first series and found that they, in general, were in good agreement.

Figure 1: Sample 1 ([redacted]0.175mm Pb) Crack Length as a Function of Cycles

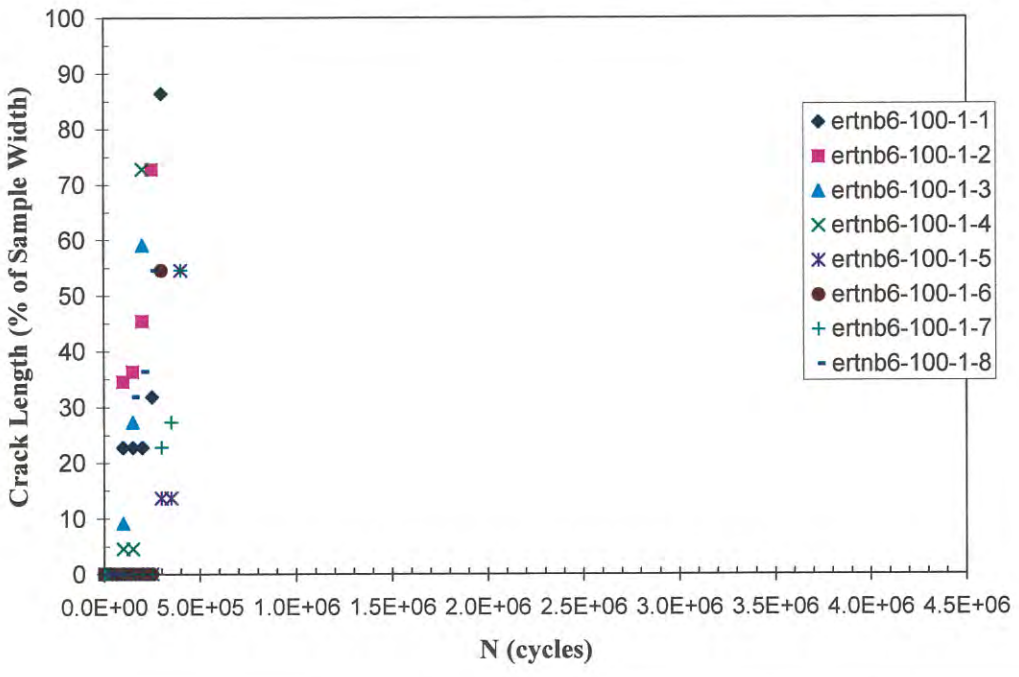


Figure 2: Sample 2 ([redacted] 0.25mm Pb) Crack Length as a Function of Cycles

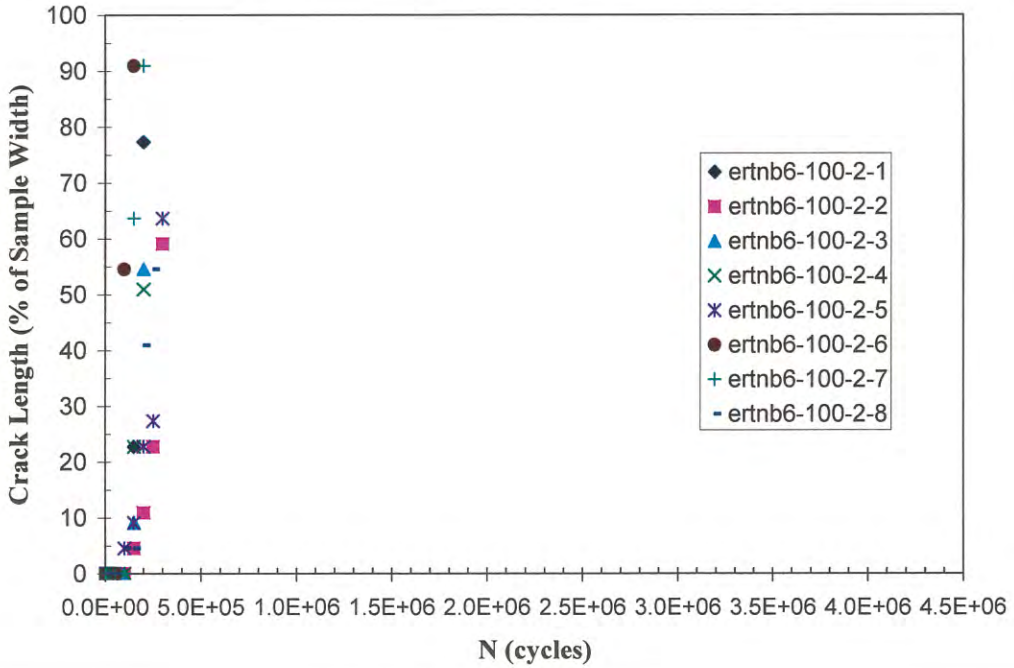


Figure 3: Sample 3 (Lite Tech B3E 0.125 mm Pb) Crack Length as a Function of Cycles

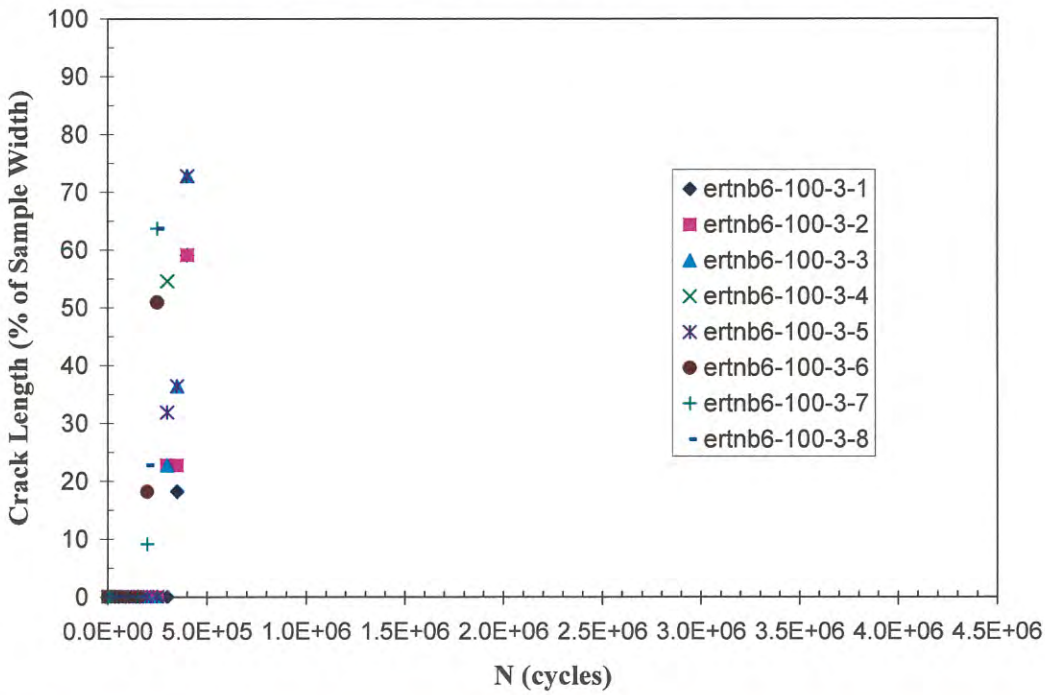


Figure 4: Sample 4 (Lite Tech TBE 40 0.125mm Pb) Crack Length as a Function of Cycles

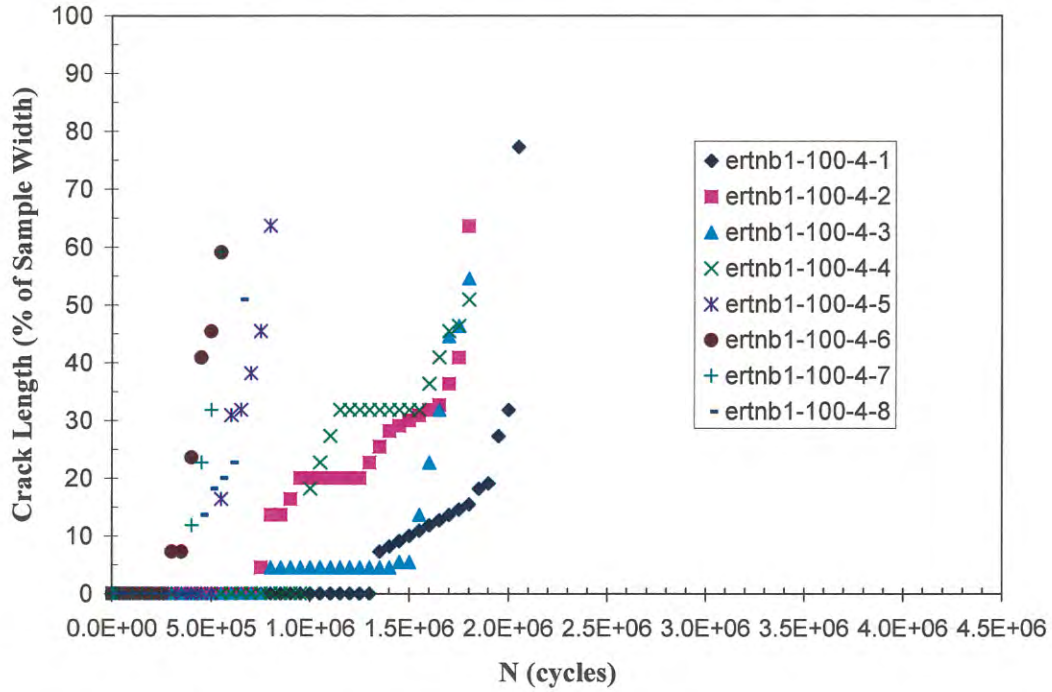


Figure 5: Sample 5 (Lite Tech TBE 36 0.125mm Pb) Crack Length as a Function of Cycles

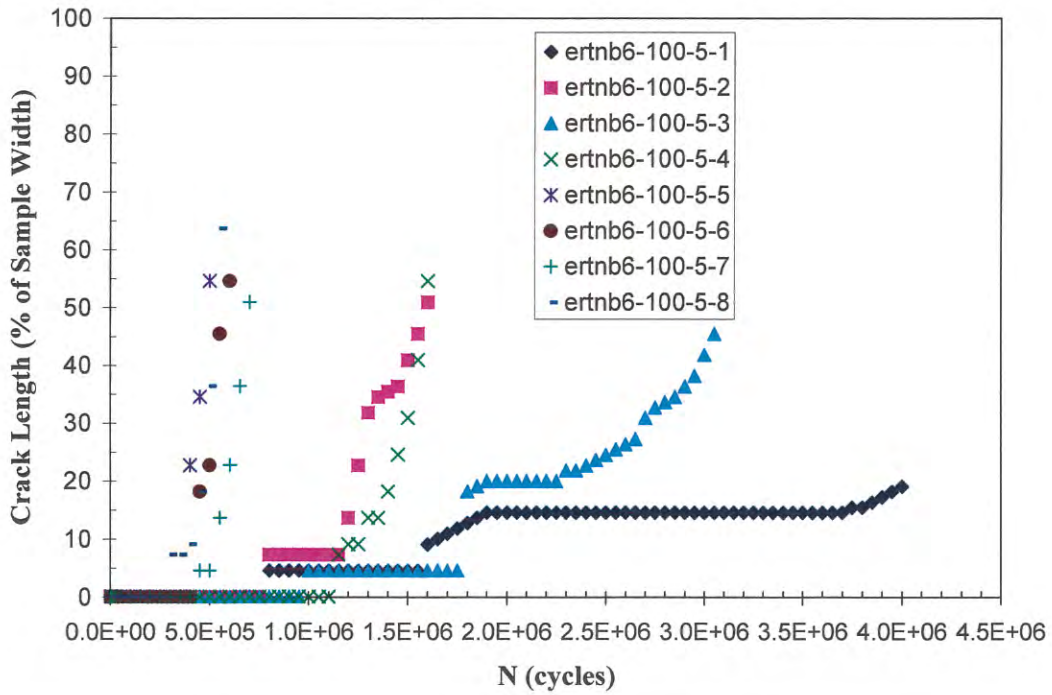


Figure 6: Sample 6 (Lite Tech TBF 0.125mm Pb) Crack Length as a Function of Cycles

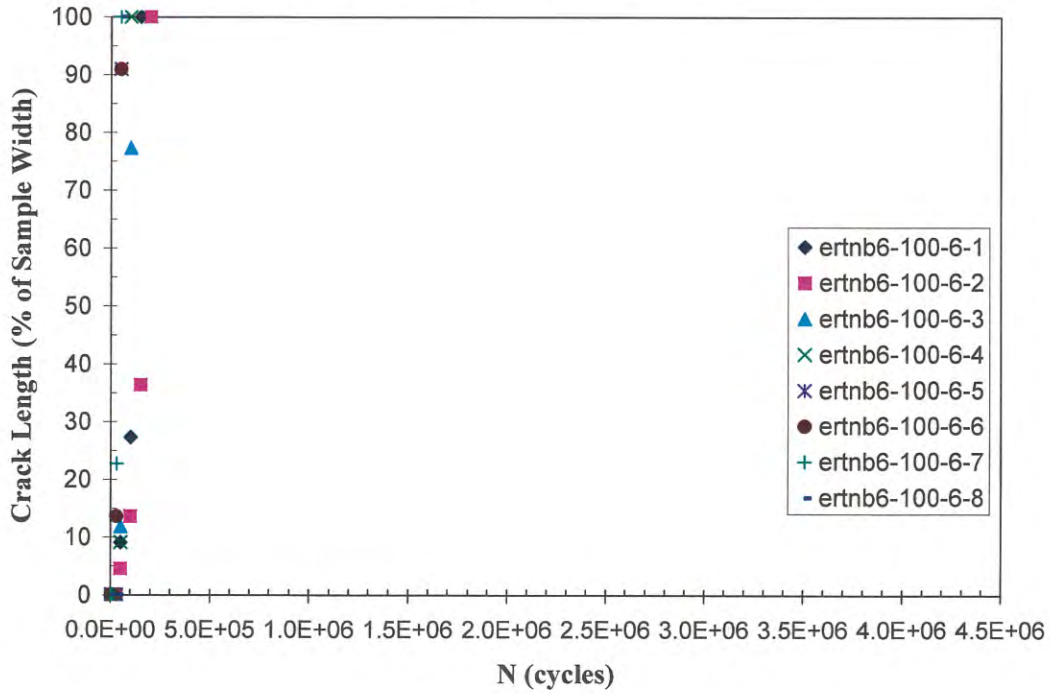


Figure 7: Sample 7 (Lite Tech TBE 33.3 0.125 mm Pb) Crack Length as a Function of Cycles

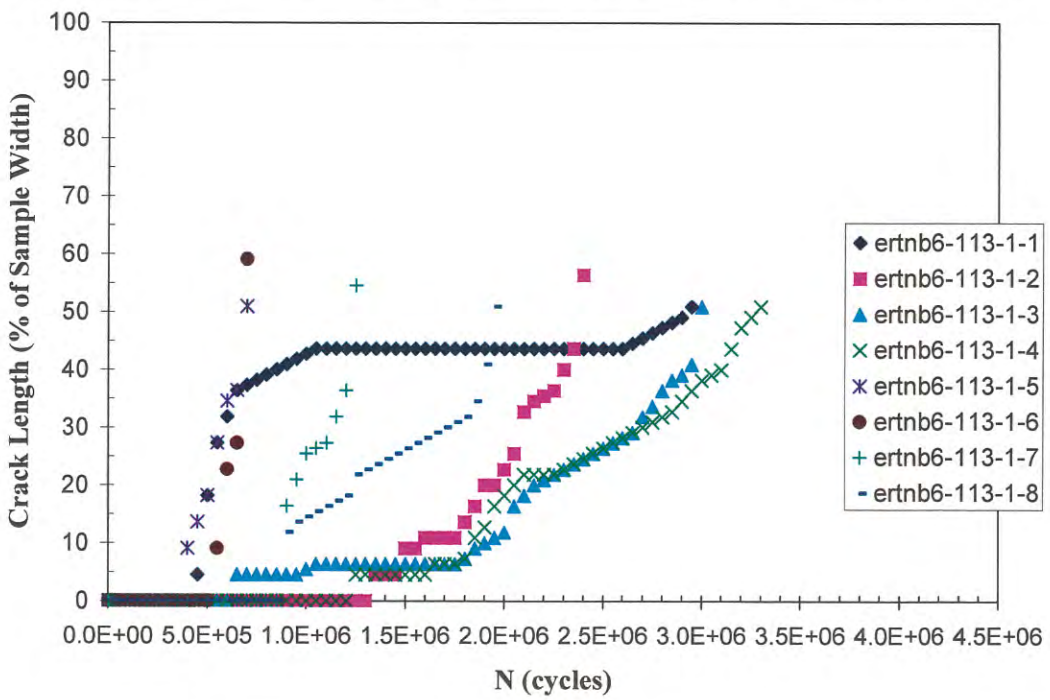


Figure 8: Sample 8 (Lite Tech NLE 0.175 mm Pb) Crack Length as a Function of Cycles

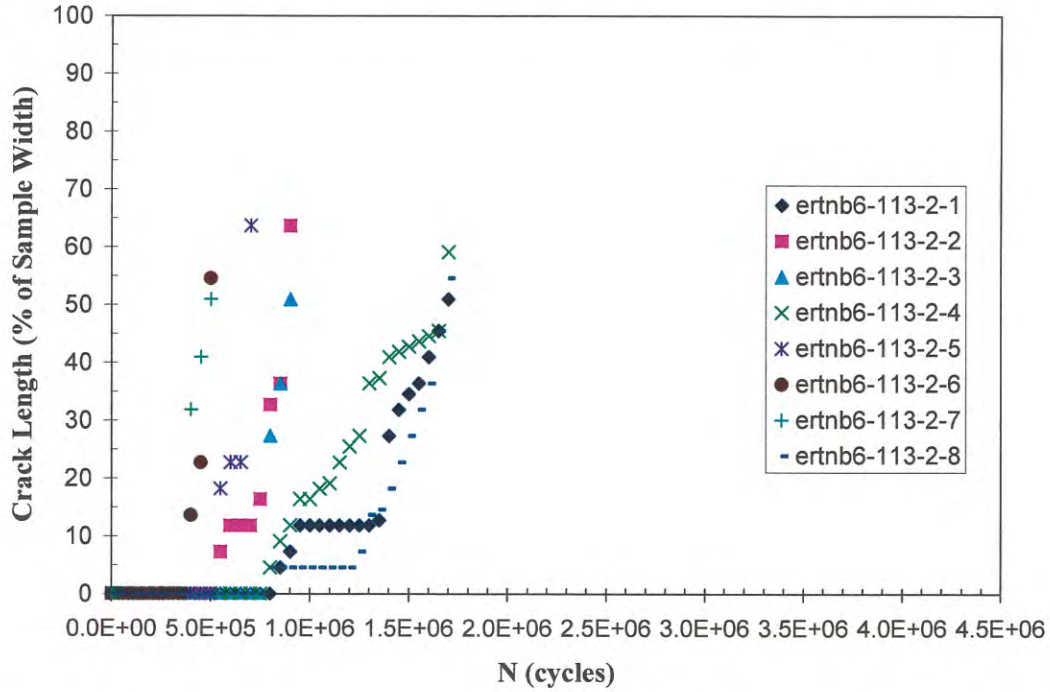


Figure 9: Sample 9 (Lite Tech [redacted]) Crack Length as a Function of Cycles

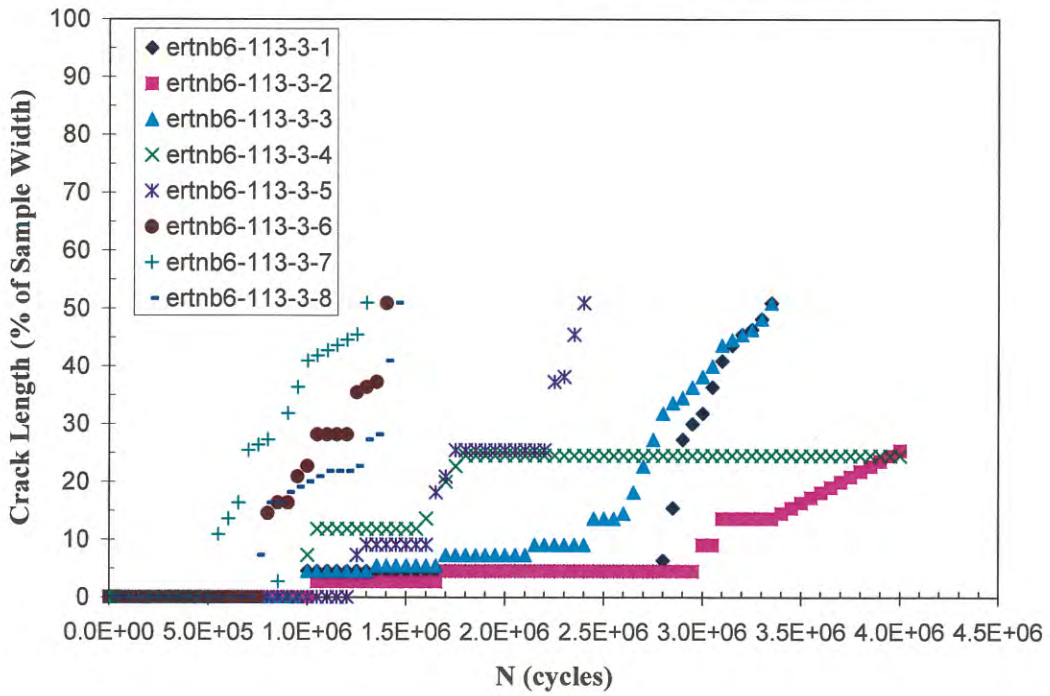
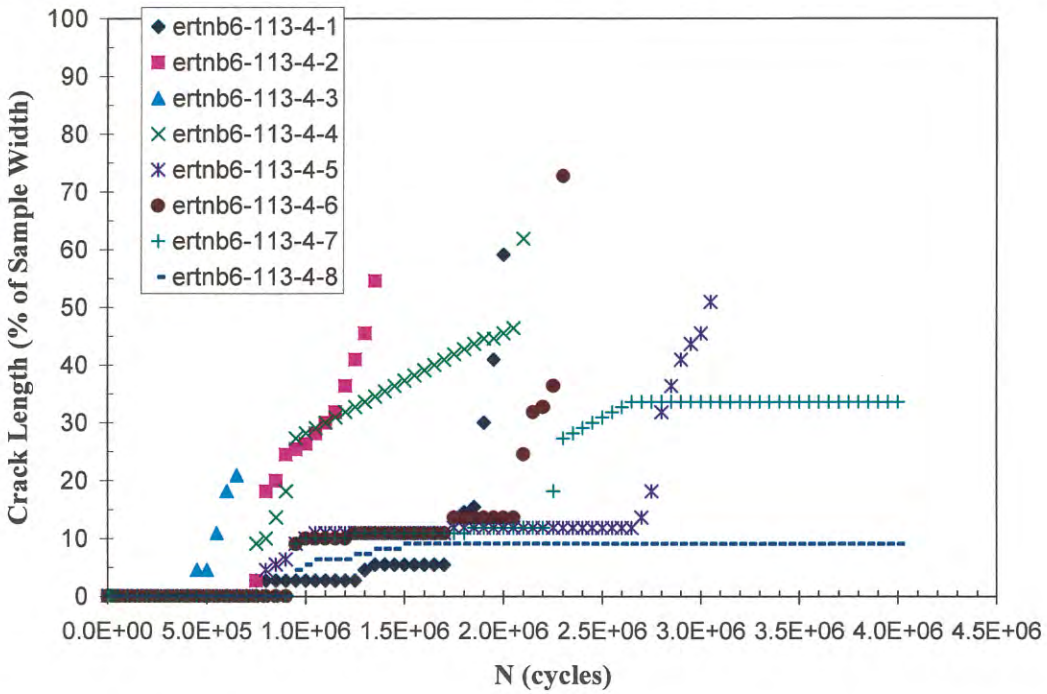


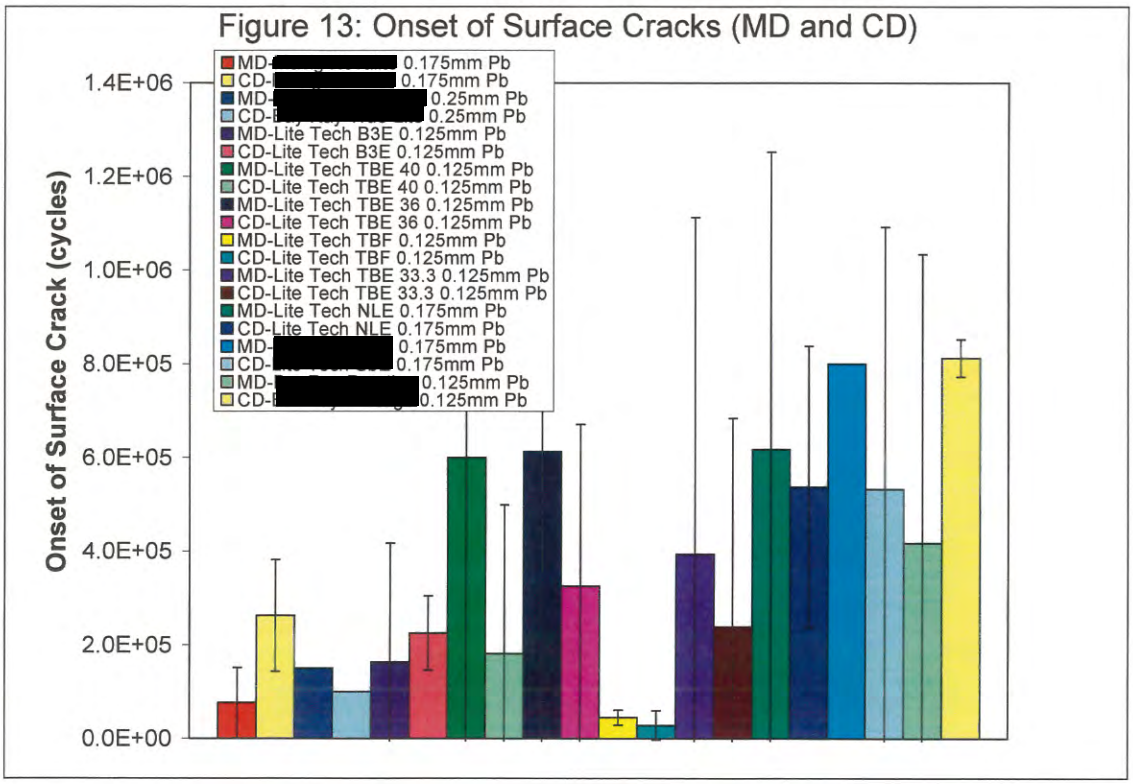
Figure 10: Sample 10 ([redacted]) Crack Length as a Function of Cycles



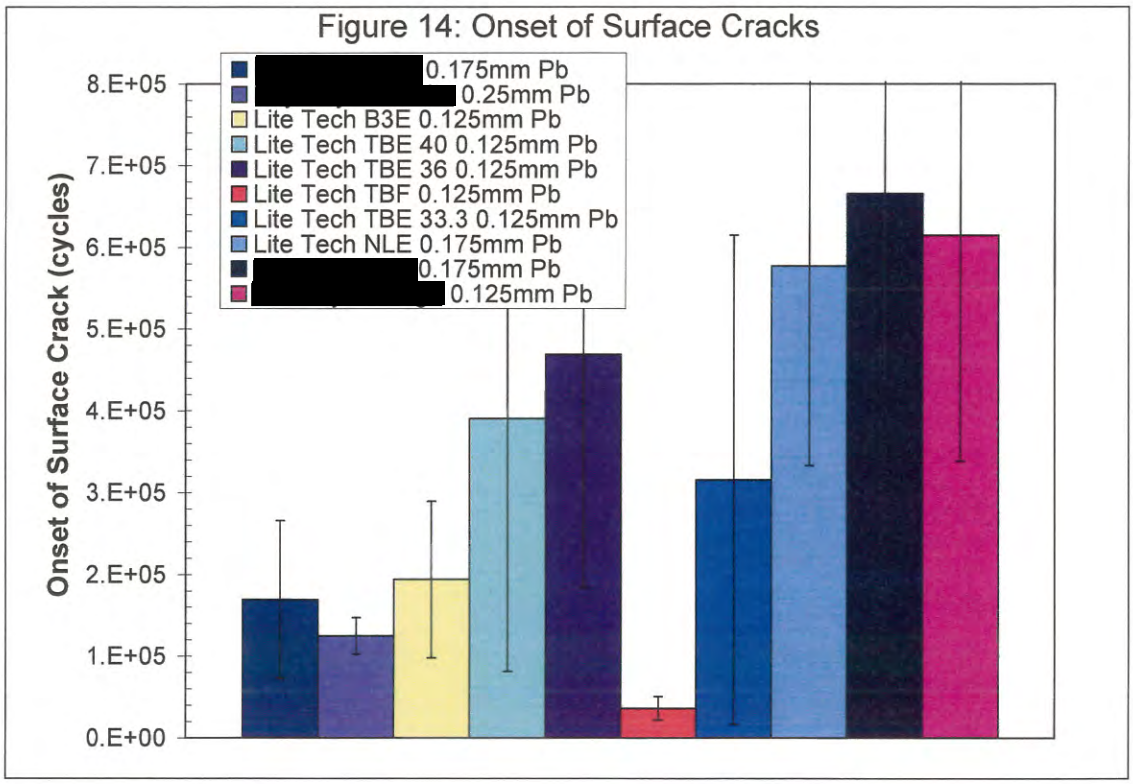
Crack Growth Rate:

The rate of surface crack growth was measured as a function of cycles (lower is better). The linear regression fit to the data was reported as inches per million cycles (Figure 11). The confidence bars show that the machine and cross directions were, in the main, not significantly different. It was noticed that, for the most part, the machine direction had a lower crack growth rate than the cross direction.

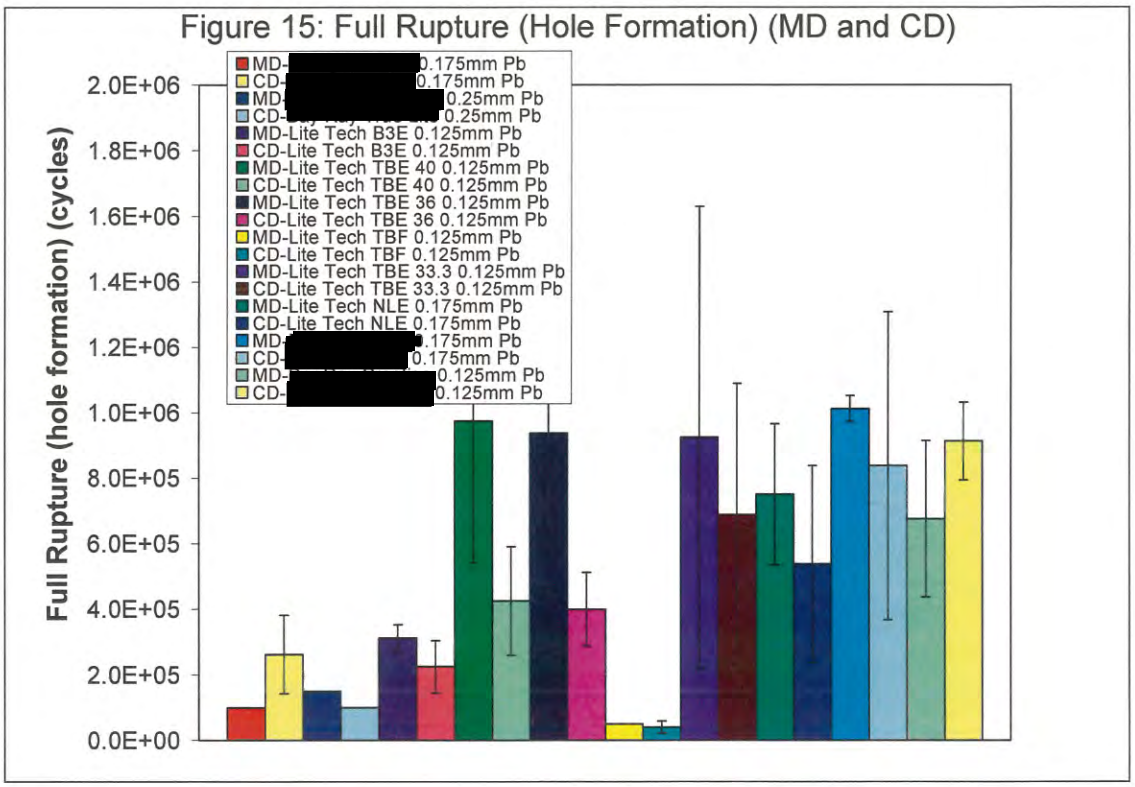
Figure 13: Onset of Surface Cracks (MD and CD)



The overall average onset of surface crack formation (combined machine and cross directions) are shown in Figure 14. The confidence bars show that most of the samples were not significantly different from each other.

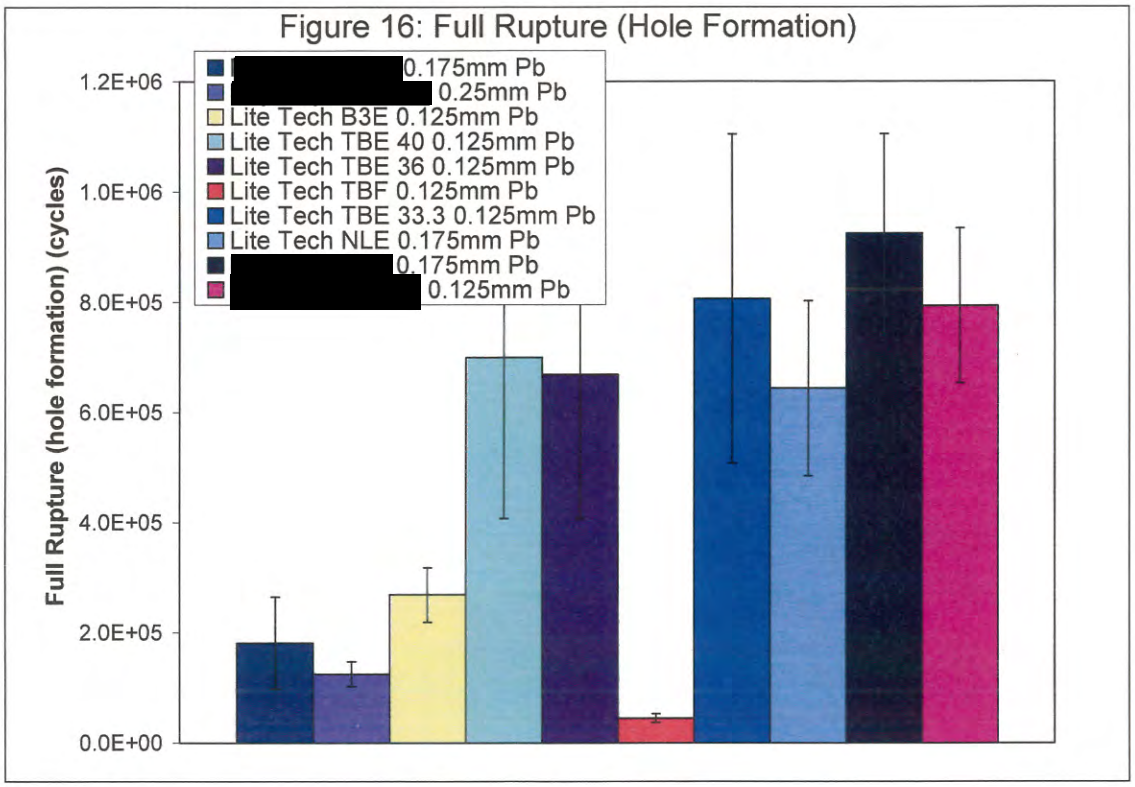


Full Rupture (Hole Formation):
Cycles to full rupture (hole formation) were determined (Figure 15). The confidence bars show that the machine and cross directions were, in the main, not significantly different. It was observed that, for the most part, the machine direction required more cycles before a hole formed than did the cross direction.



The overall average full rupture (hole formation) results (the combined results of machine direction and cross direction) are shown in Figure 16. The order of performance rating from best to worst was 9>7>10>4>5>8>3>1>2>6. The confidence bars show that samples 4, 5, 7, 8, 9 and 10 were not significantly different from each other. Sample 1 was not significantly different from samples 2 and 3, but sample 2 was significantly different from sample 3. Only sample 6 was significantly different from all of the other samples.

Figure 16: Full Rupture (Hole Formation)



Prepared By: _____ Approved By: _____

Jonathan Martens
Research Chemist

Edward R Terrill, Ph.D.
Applied Research Fellow