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FROM: PROI (STINFO)

22 May 2002

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-VG-2002-130**
C.T. Liu (PRSM); F.P. Chiang (NYSU), "Investigating the Deformation and Failure Mechanisms in Bi-Material Systems Under Tension"

ASME Winter Meeting
(Blacksburg, VA, 24-28 June 2002) **(Deadline = 23 June 2002)**

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PHILIP A. KESSEL Date
Technical Advisor
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Investigating the Deformation and Failure Mechanisms in Bi-Material Systems under Tension

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Objectives

¥ Investigate the Local Strain Distribution and Failure Mode in a Bi-Material Bonded

—Specimens under a Constant Displacement Rate Condition.

* Displacement Rate = 0.02 in/min

¥ Determine the Critical Strain for Debond at the Interface between the Two Materials.

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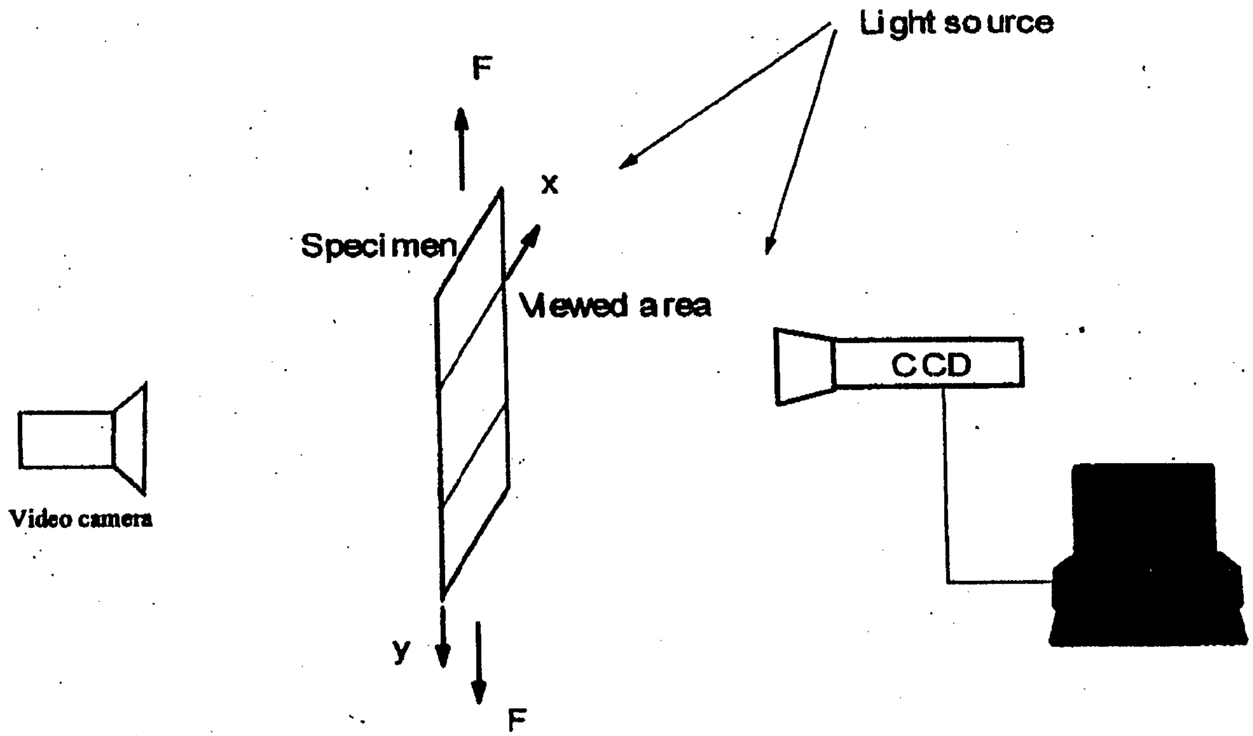
Experimental Set-Up



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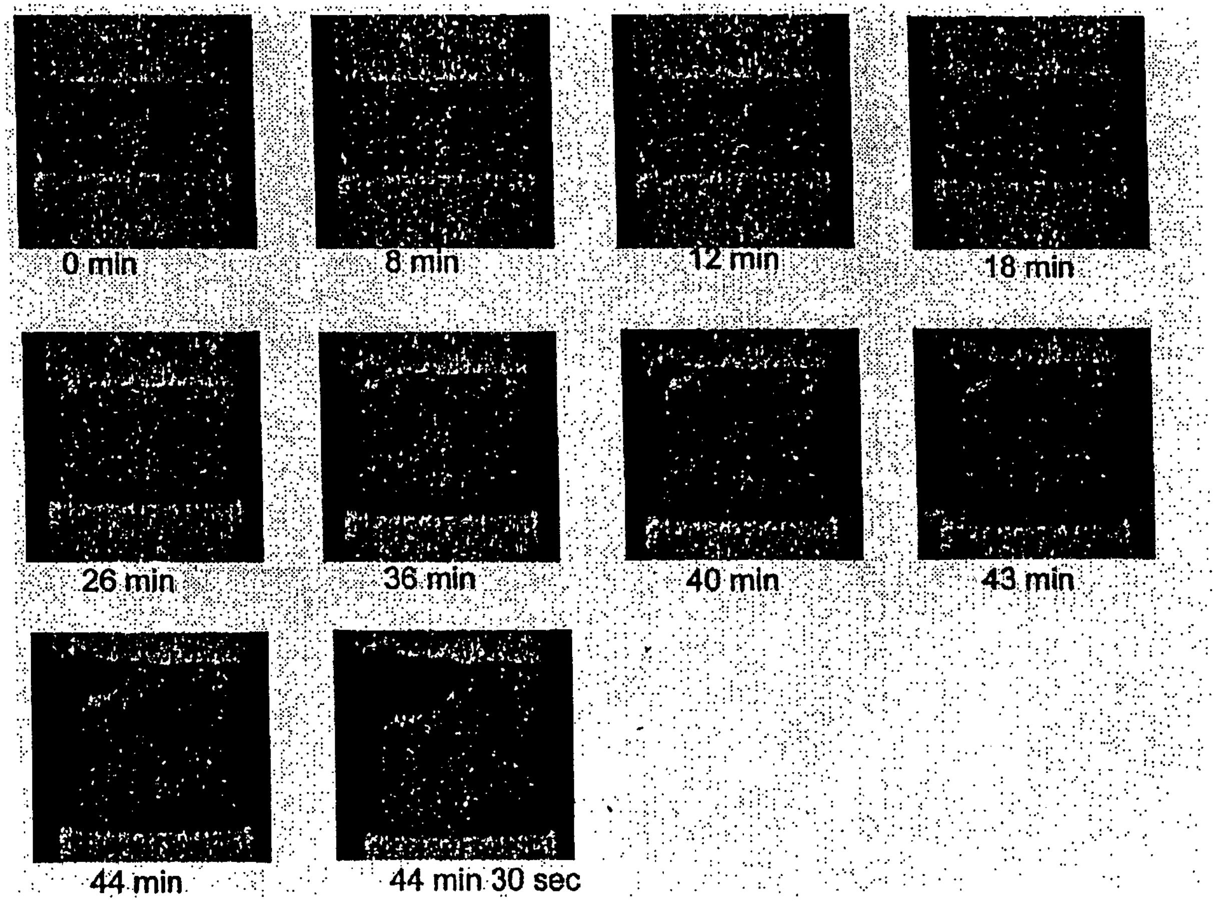
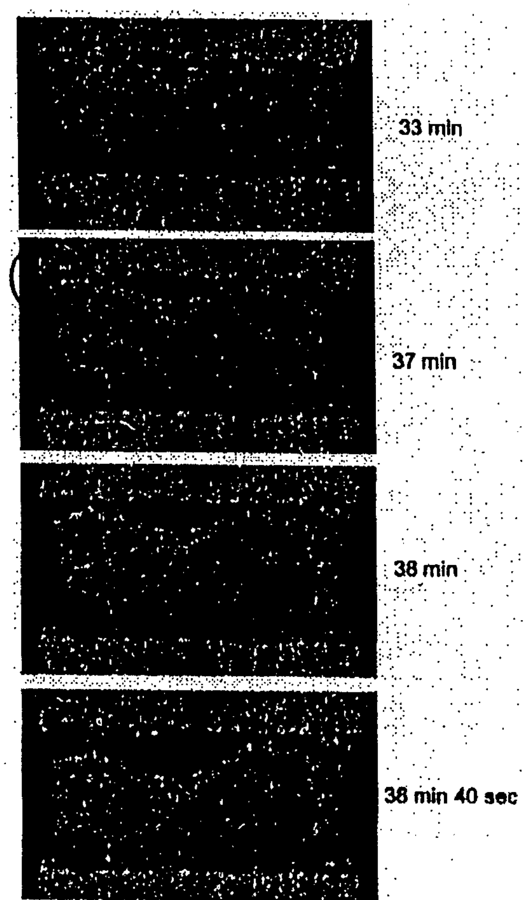
The Mechanism of Debonding

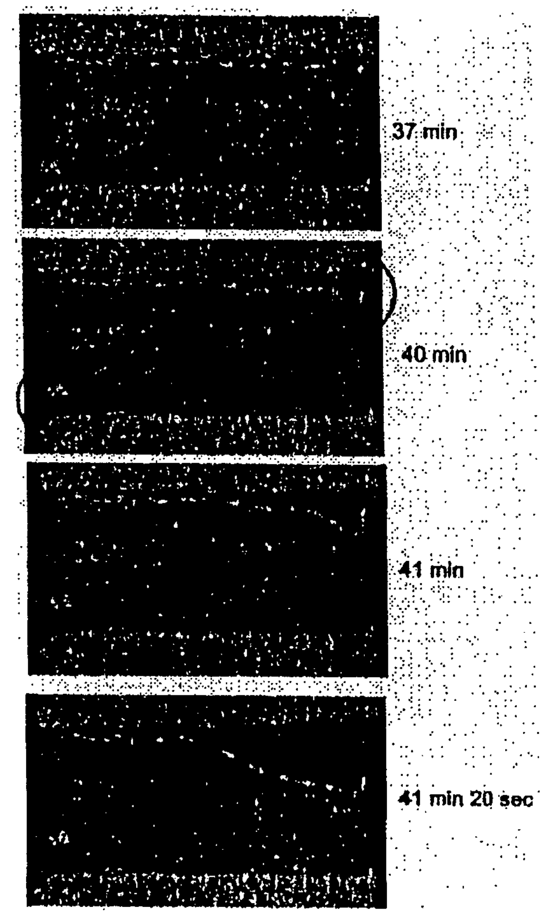
Thickness to Width Ratio: 1:1:00



The Mechanism of Debonding

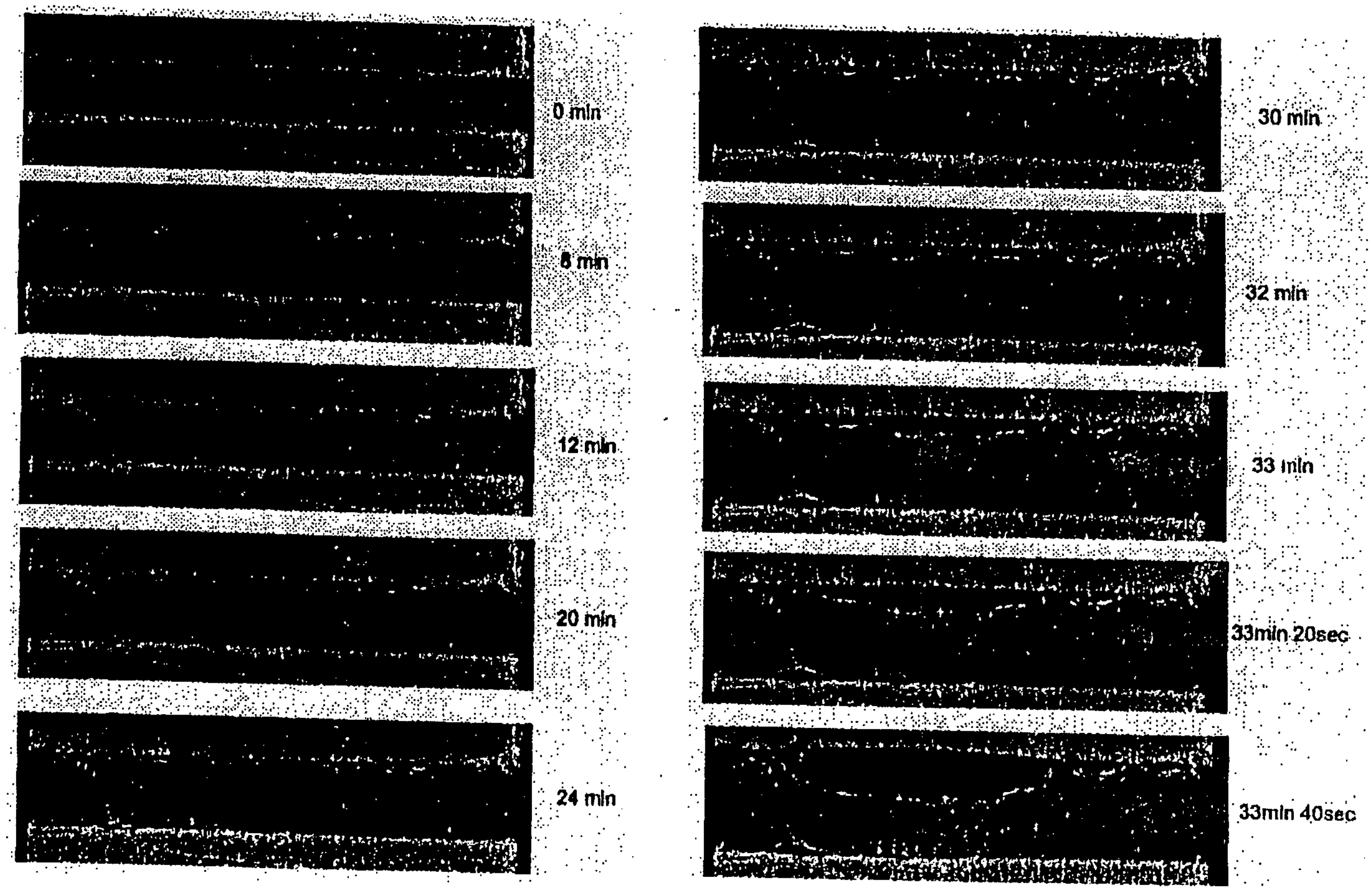
Thickness to Width Ratio: 1:2.25





The Mechanism of Debonding

Thickness to Width Ratio: 1:5.00



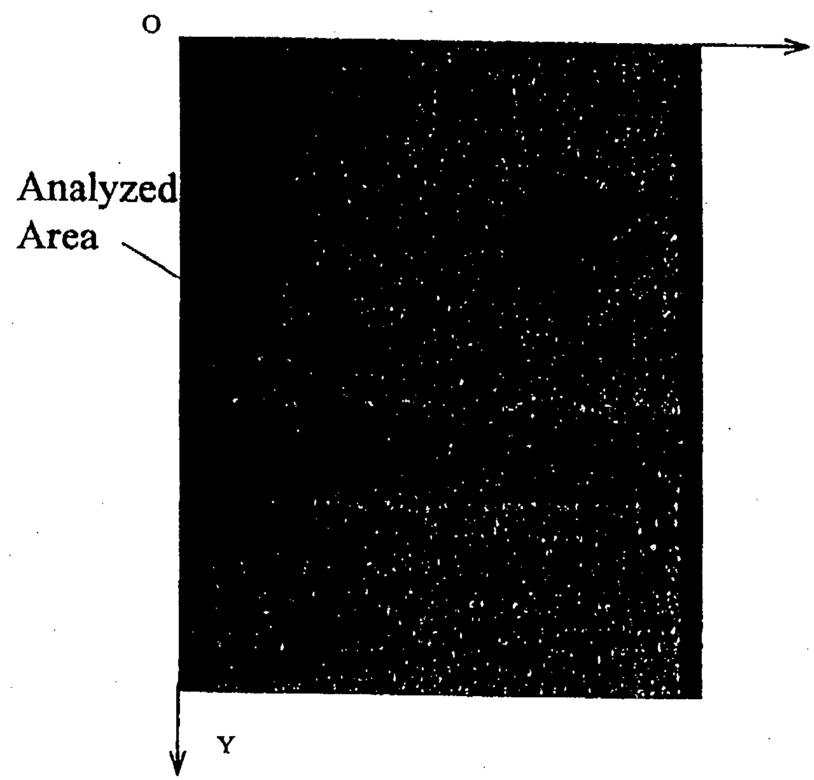
The Debonding Modes

H ~ 4 in
h ~ 0.1 in

Size: t x w (in)	Ratio: t:w	Number of Specimens	Debond at center	Debond at corner
0.2 x 1	1:5	2	2	0
0.2 x 0.5	1:2.5	3	3	0
0.2 x 0.4	1:2	4	1	3
0.2 x 0.2	1:1	2	0	2

Critical ratio: ~ 1:2.25; either mode may prevail

Analysis of Deformation



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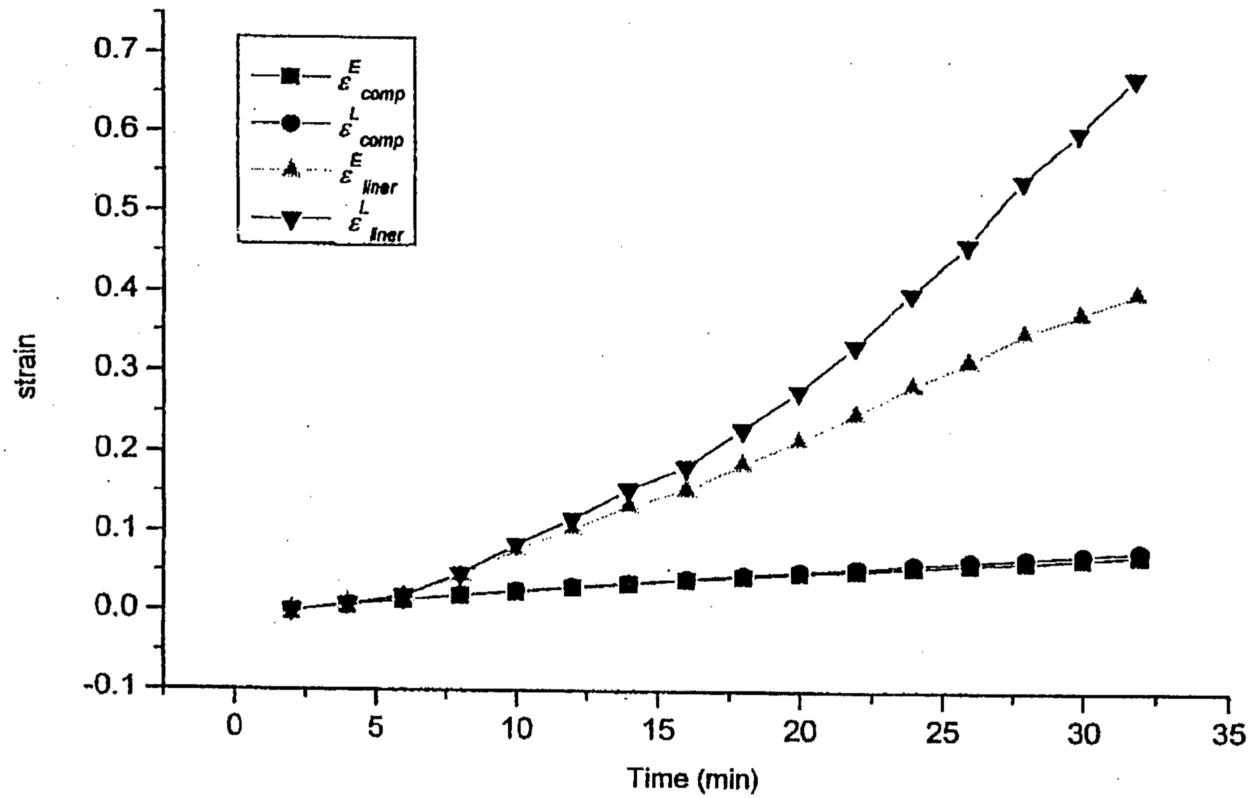
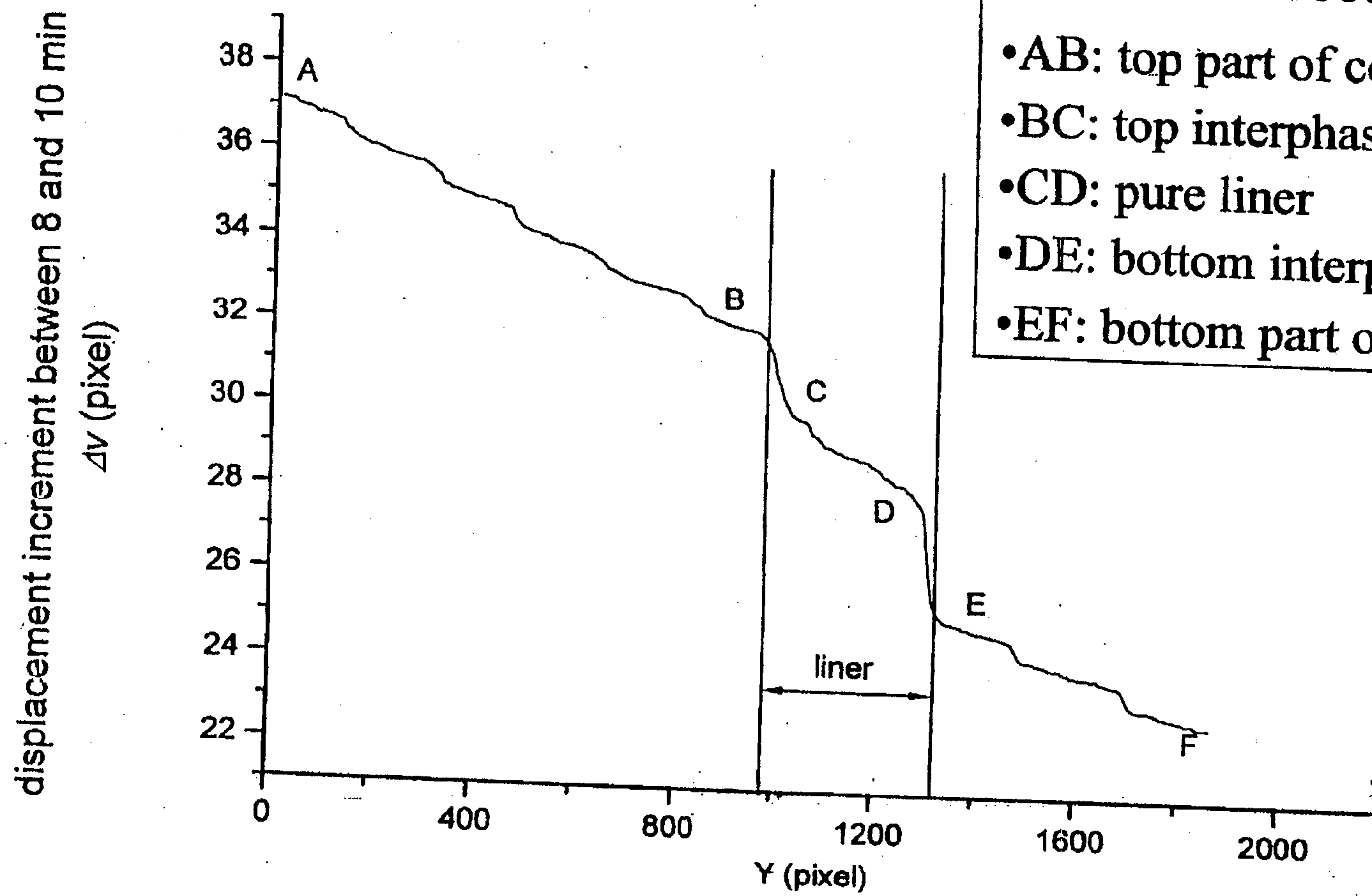
Average Strain Versus Force Curves

Thickness to Width Ratio: 1:5.00



Displacement Increment Distribution along y Direction

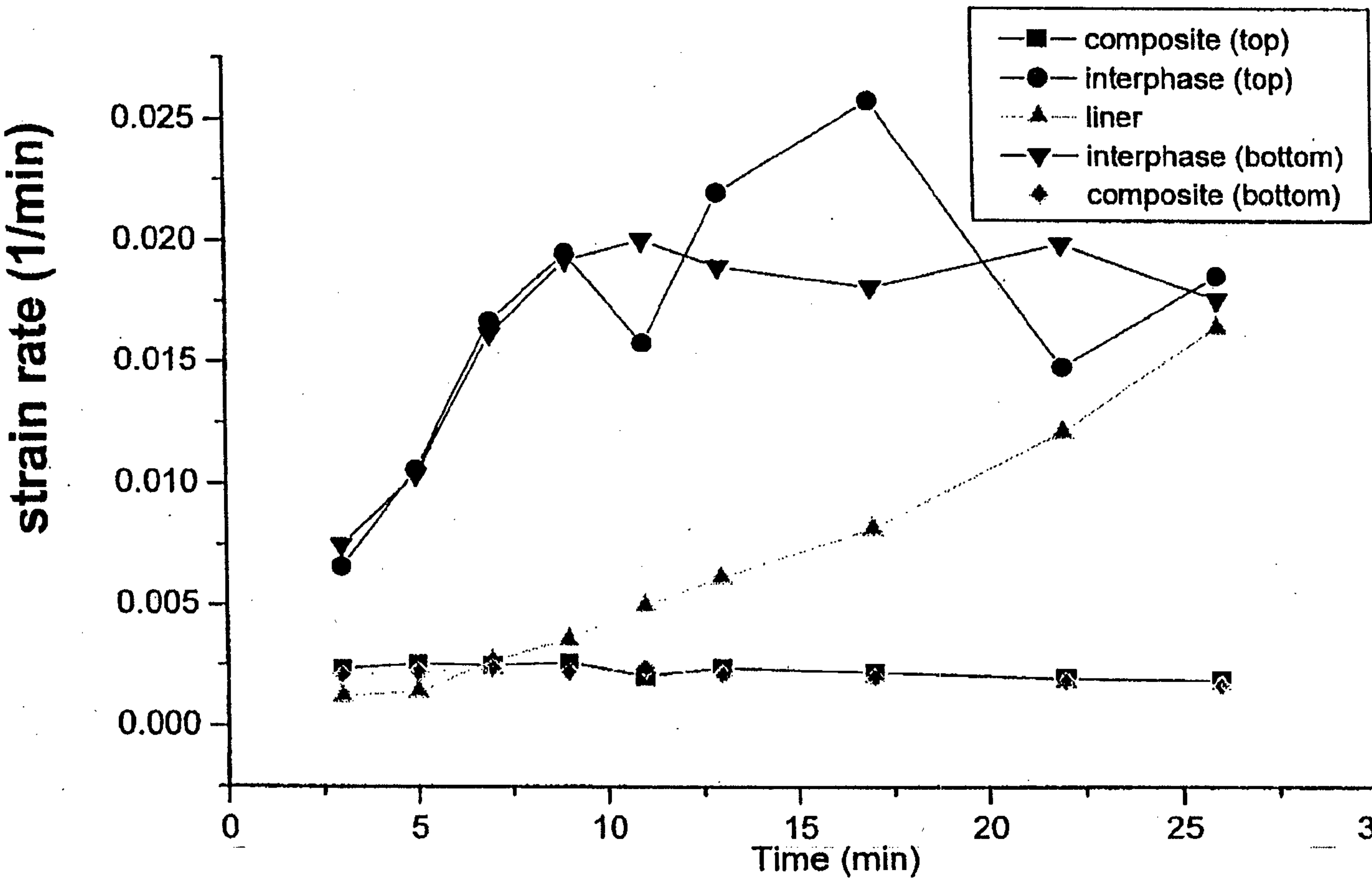


Five linear sections:

- AB: top part of composite
- BC: top interphase
- CD: pure liner
- DE: bottom interphase
- EF: bottom part of composite

Strain Rate versus Time Curves

Thickness to Width Ratio: 1:2.25



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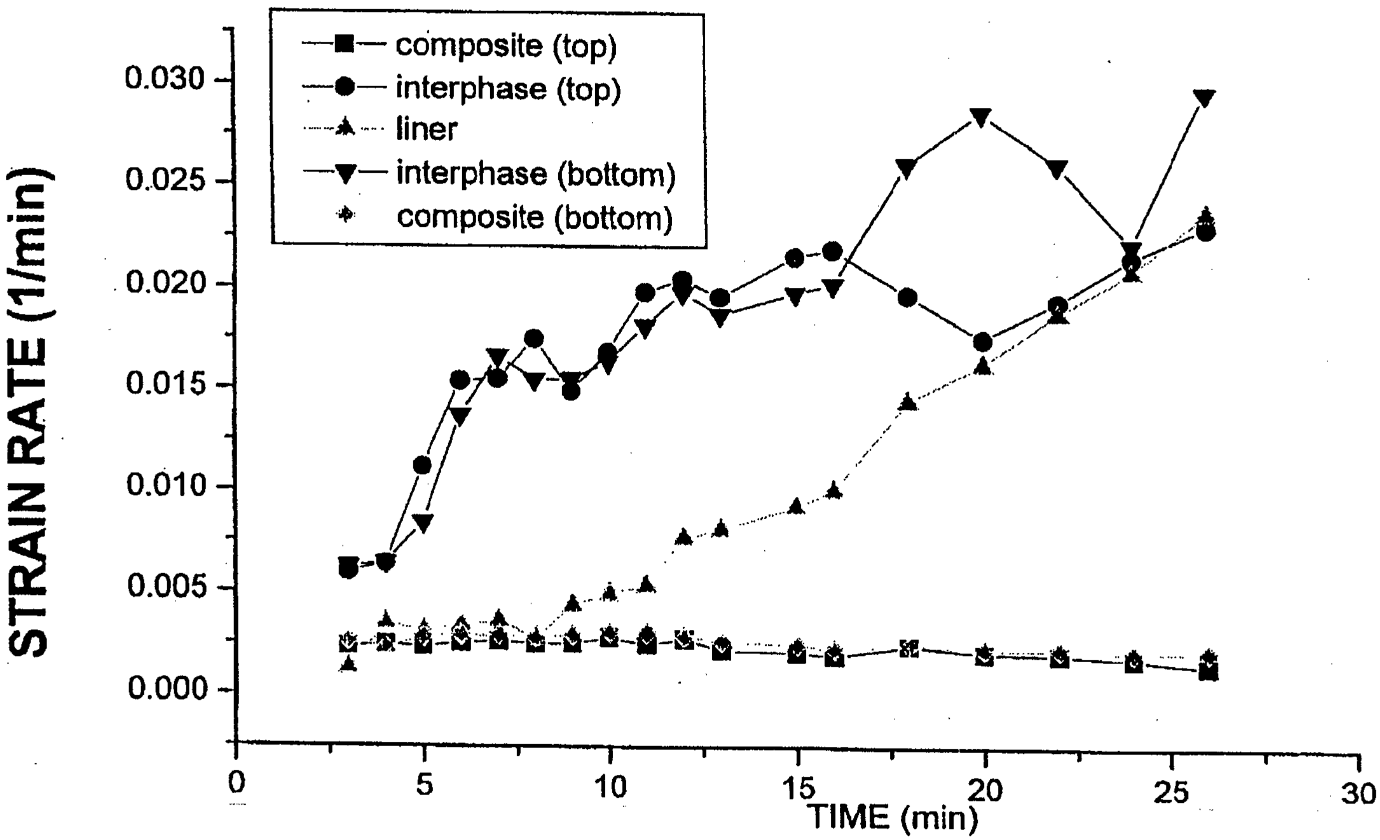
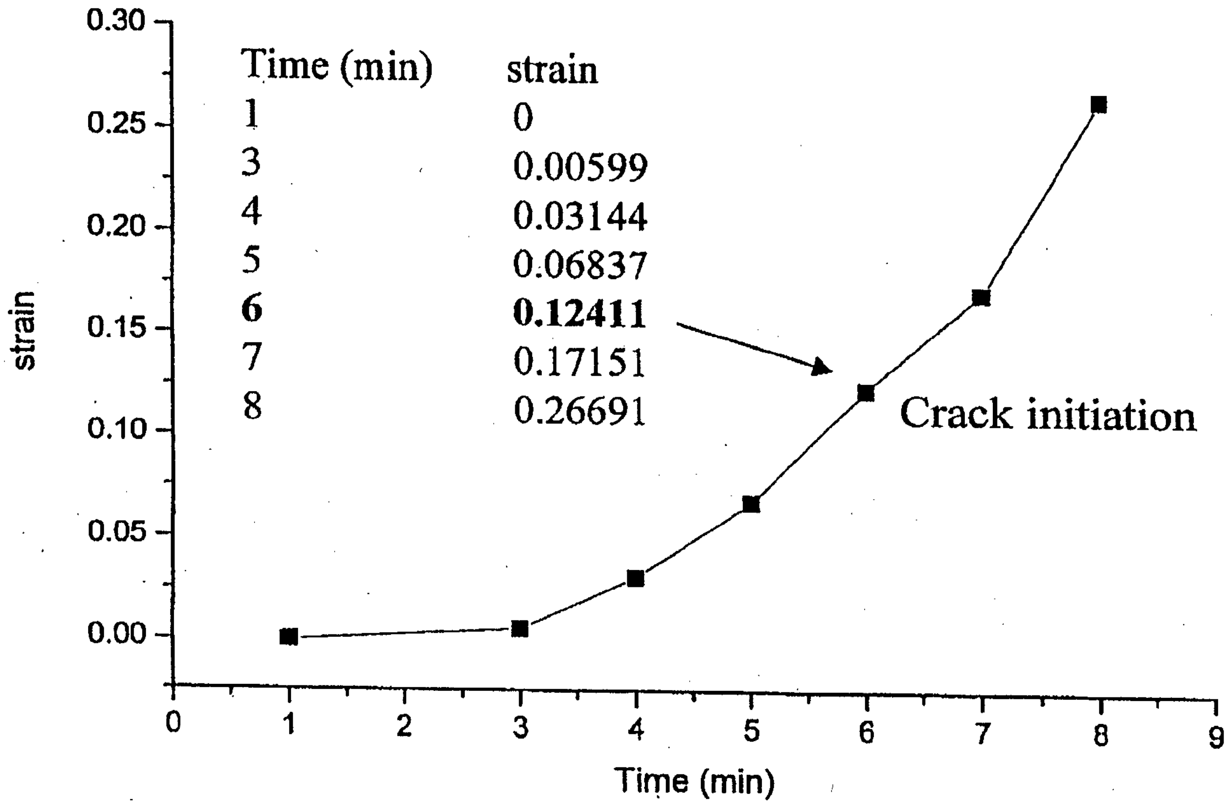
Strain Rate versus Time Curves

Thickness to Width Ratio: 1:5.00



The Time History of Local Strain near Interface



Time (min)	strain
1	0
3	0.00599
4	0.03144
5	0.06837
6	**0.12411**
7	0.17151
8	0.26691

Summary of Debonding Initiation Strain

Specimen #	Size: t x w (in)	Ratio: t:w	Crack initiation strain
k	0.2 x 1	1:5	0.12
n	0.2 x 0.5	1:2.5	0.14
w	0.2 x 0.45	1:2.25	0.13
o	0.2 x 0.2	1:1	0.13

Conclusions

¥ The Failure location depends on the geometry of the specimen.

¥ There are interphase regions near the interfaces of the specimen.

¥ The strain rates in the rubber layer and the interface region change with time.

¥ The strain rate in the interphase region is significant ly higher than that in the rubber and the composite layers.

¥ The average critical local debond strain is 13%, which is independent of specimen geometry.