REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
	Technical Papers	

4. TITLE AND SUBTITLE

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

5d. PROJECT NUMBER
1011

5e. TASK NUMBER
CA9F

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Air Force Research Laboratory (AFMC)
AFRL/PRS
5 Pollux Drive
Edwards AFB CA 93524-7048

8. PERFORMING ORGANIZATION REPORT

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Air Force Research Laboratory (AFMC)
AFRL/PRS
5 Pollux Drive
Edwards AFB CA 93524-7048

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

20030110 137

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Leilani Richardson
Unclassified	Unclassified	Unclassified	A		19b. TELEPHONE NUMBER *(include area code)* (661) 275-5015

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. 239.18

18 separate items enclosed

TP-1998-1Ø4

1011CH 9F

MEMORANDUM FOR PRS (Contractor Publication)

FROM: PROI (TI) (STINFO) 18 May 1998

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-TP-1998-104**
Tim Miller (SPARTA) "Modeling of Interfacial Fracture in Photoelastic Specimens"
Vugraphs **(Statement A)**

Modeling of Interfacial Fracture in Photoelastic Specimens

T.C. Miller

Sparta, Incorporated

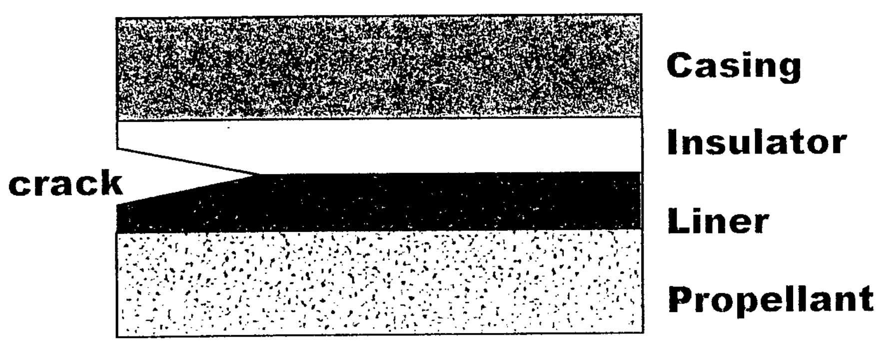
Air Force Research Laboratory

Edwards Air Force Base, California

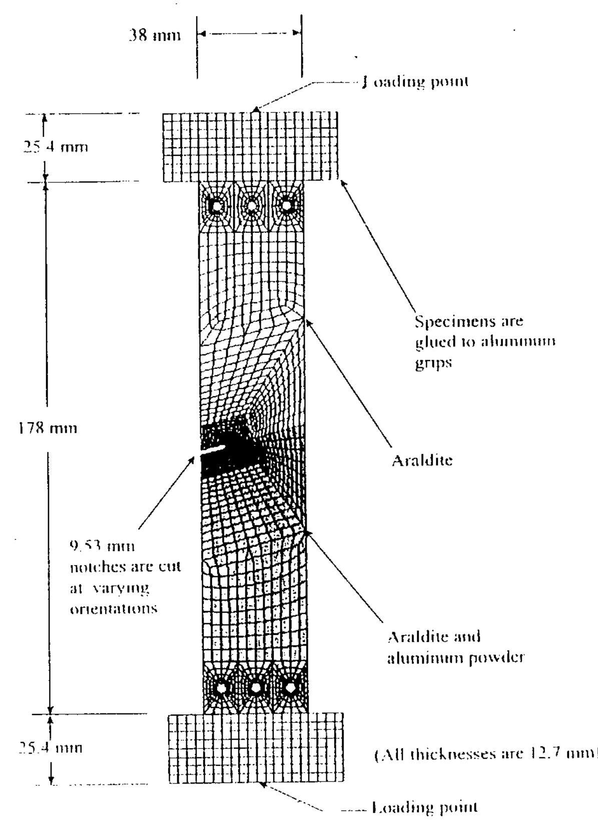
June 1998

Introduction

Applications to Composite Structures



Related Photoelastic Stress Freezing Experiments



Incompressible Bimaterial Paris Under Plane Strain Conditions

General Interfacial Fracture

$\epsilon \neq 0 \qquad \beta \neq 0$

$$\sigma_{pq} = \frac{1}{\sqrt{2\pi r}}\{Re(Kr^{i\epsilon})\Sigma^{I}_{pq}(\theta) + Im(Kr^{i\epsilon})\Sigma^{II}_{pq}(\theta)\}$$

$$(\sigma_{yy} + i\sigma_{xy})_{\theta=0} = \frac{Kr^{i\epsilon}}{\sqrt{2\pi r}} = \frac{K_1 + iK_2}{\sqrt{2\pi r}}[\cos(\epsilon Lnr) + i\sin(\epsilon Lnr)]$$

$$J = G = \frac{\Lambda_1 + \Lambda_2}{16\cosh^2(\pi\epsilon)}|K|^2$$

Plane Strain/Incompressible Materials

$\epsilon = 0 \qquad \beta = 0$

$$\sigma_{pq} = \frac{1}{\sqrt{2\pi r}}\{Re(K)\Sigma^{I}_{pq}(\theta) + Im(K)\Sigma^{II}_{pq}(\theta)\}$$

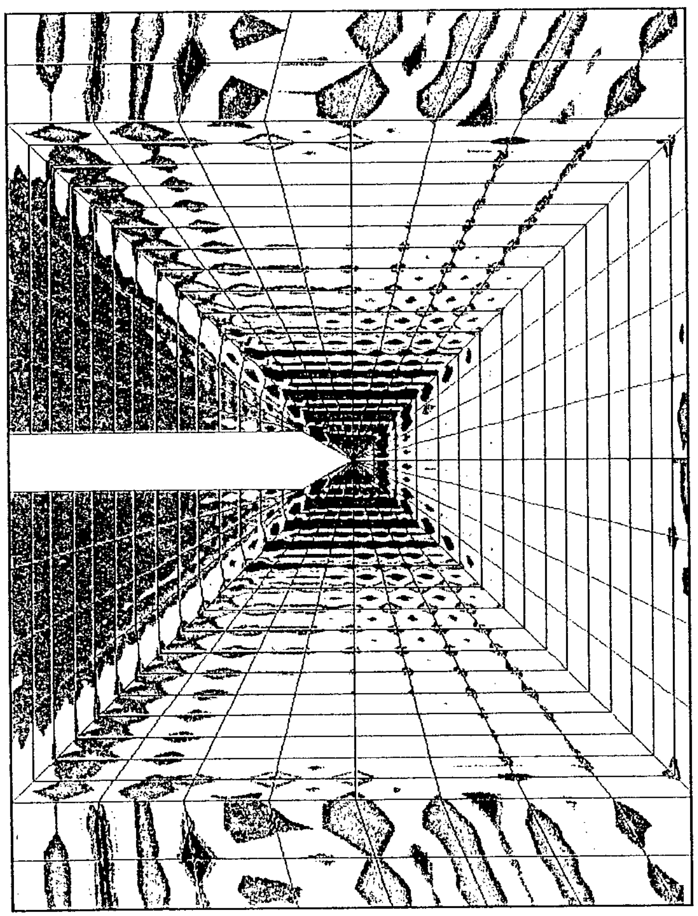
$$(\sigma_{yy} + i\sigma_{xy})_{\theta=0} = \frac{K}{\sqrt{2\pi r}} = \frac{K_1 + iK_2}{\sqrt{2\pi r}}$$

$$J = G = \frac{K^2}{E^*}, \quad \frac{1}{E^*} = \frac{1}{2}[\frac{1}{\overline{E}_1} + \frac{1}{\overline{E}_2}], \quad \overline{E}_1 = \frac{E_1}{1 - \nu_1^2}, \quad \overline{E}_2 = \frac{E_2}{1 - \nu_2^2}$$

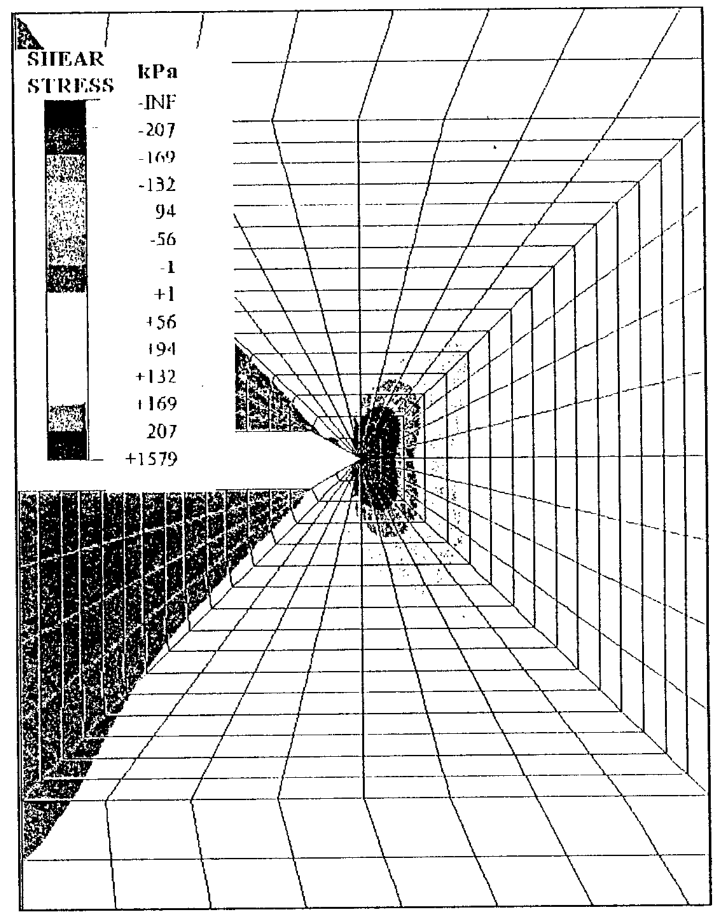
AIR FORCE RESEARCH LABORATORY

Hybrid Elements and Mixed Formulation Prevent Ill-Conditioning Problems

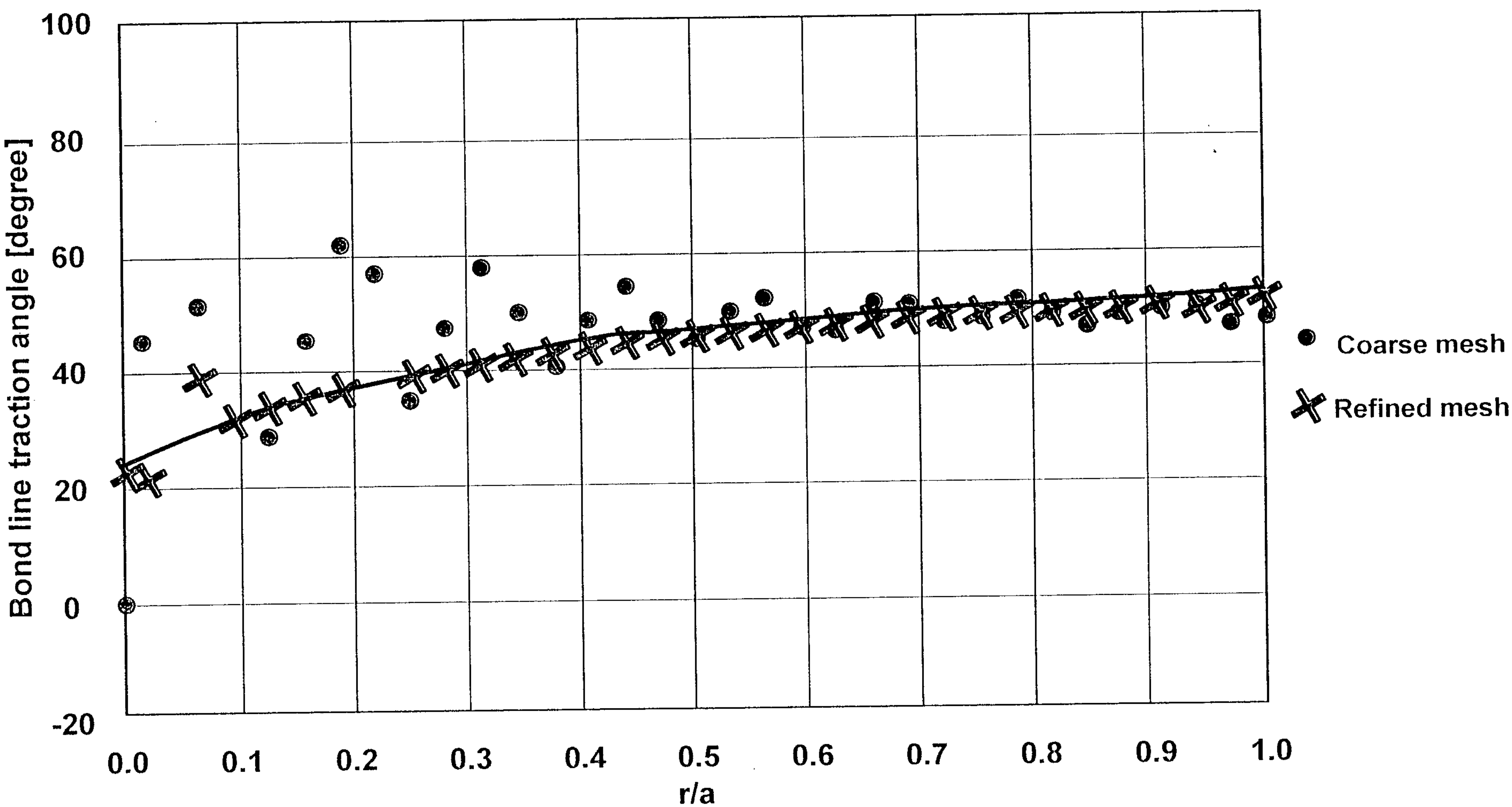
Conventional Formulation



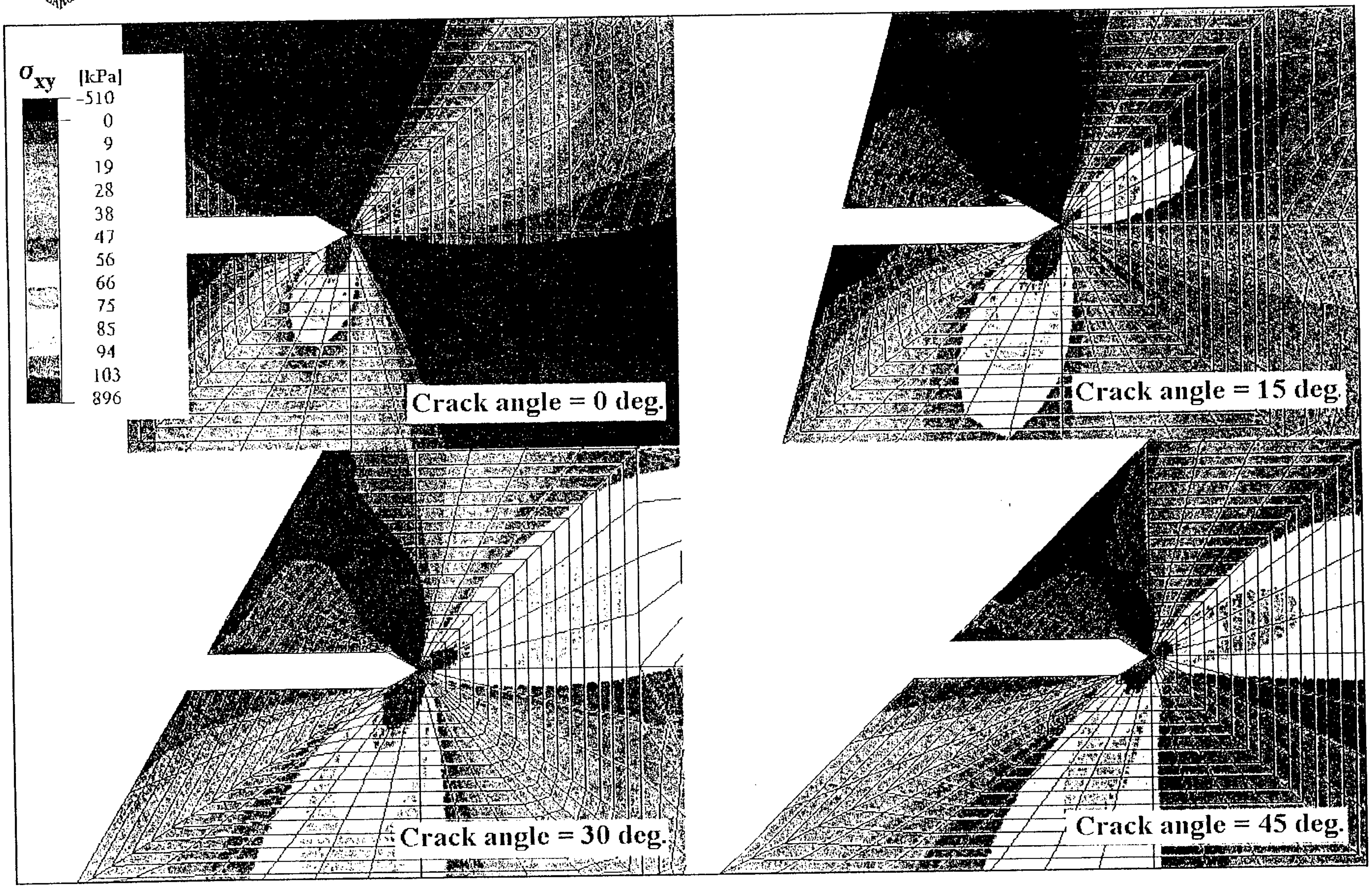
Mixed Formulation



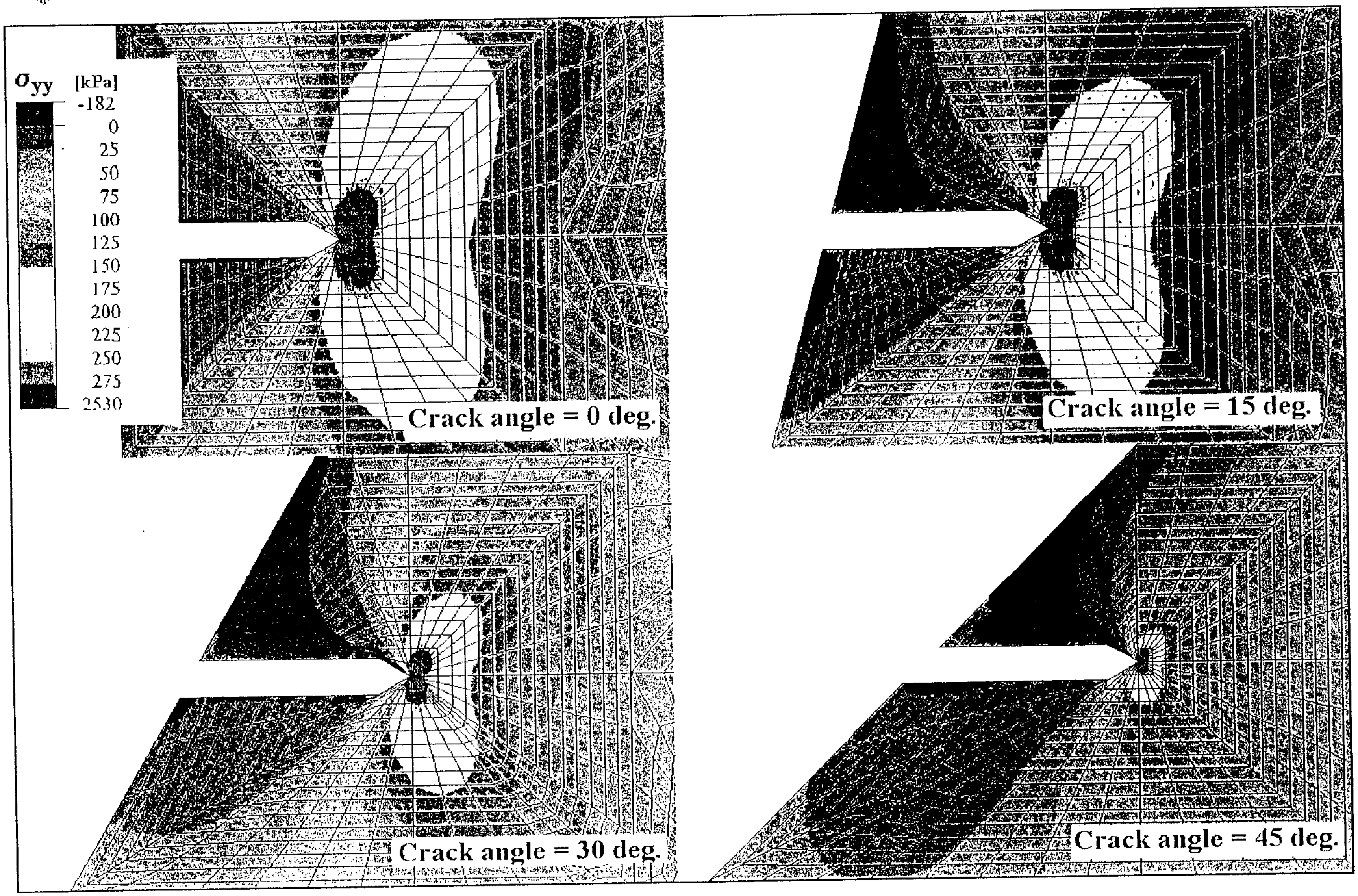
A Refined Mesh is Used to Provide Accurate Bond Line Tractions



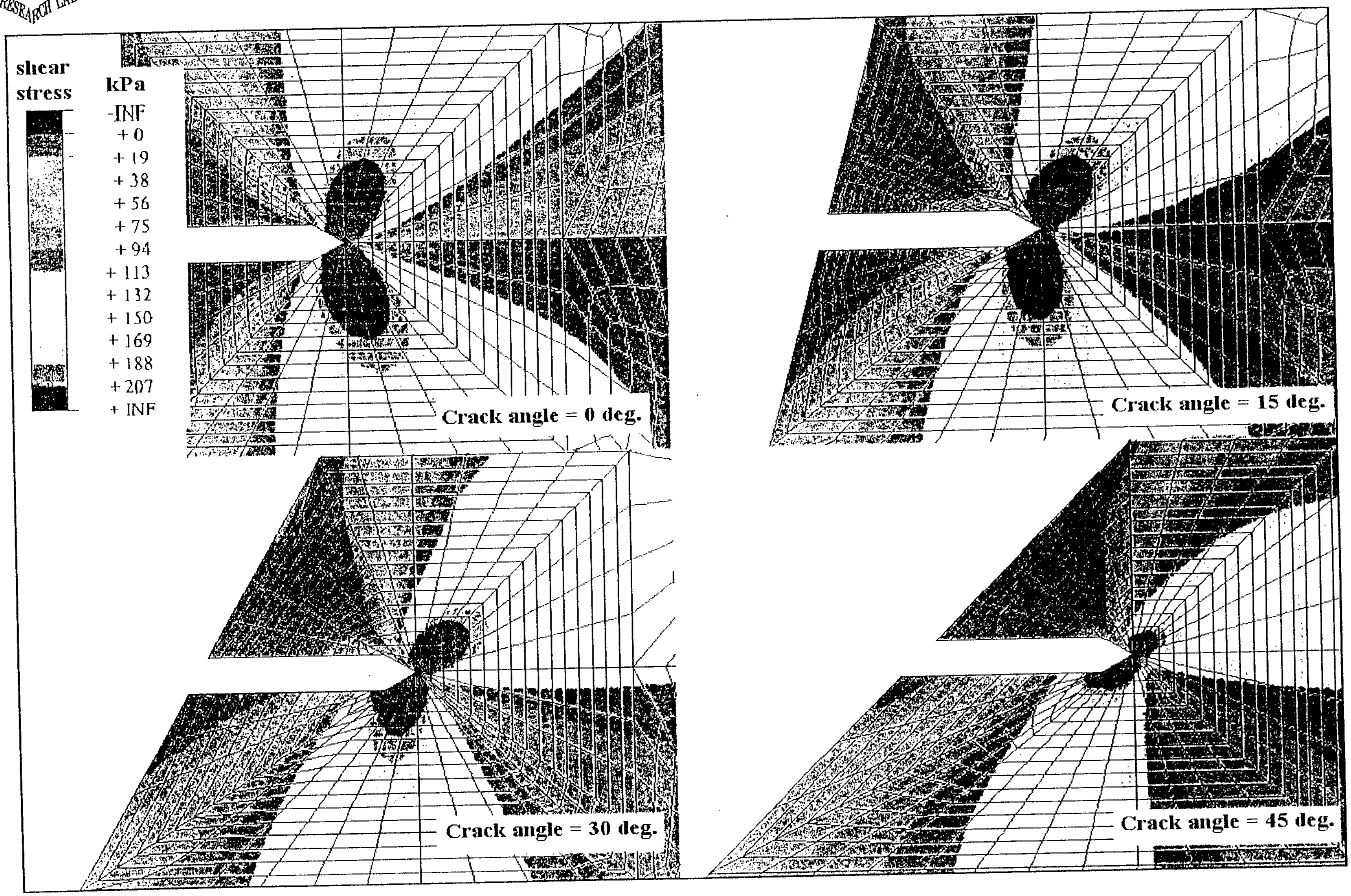
Contour Plots of In-Plane Shear Stress for Various Mode Mixities



Contour Plots of σ_{yy} Stress Component for Various Mode Mixities

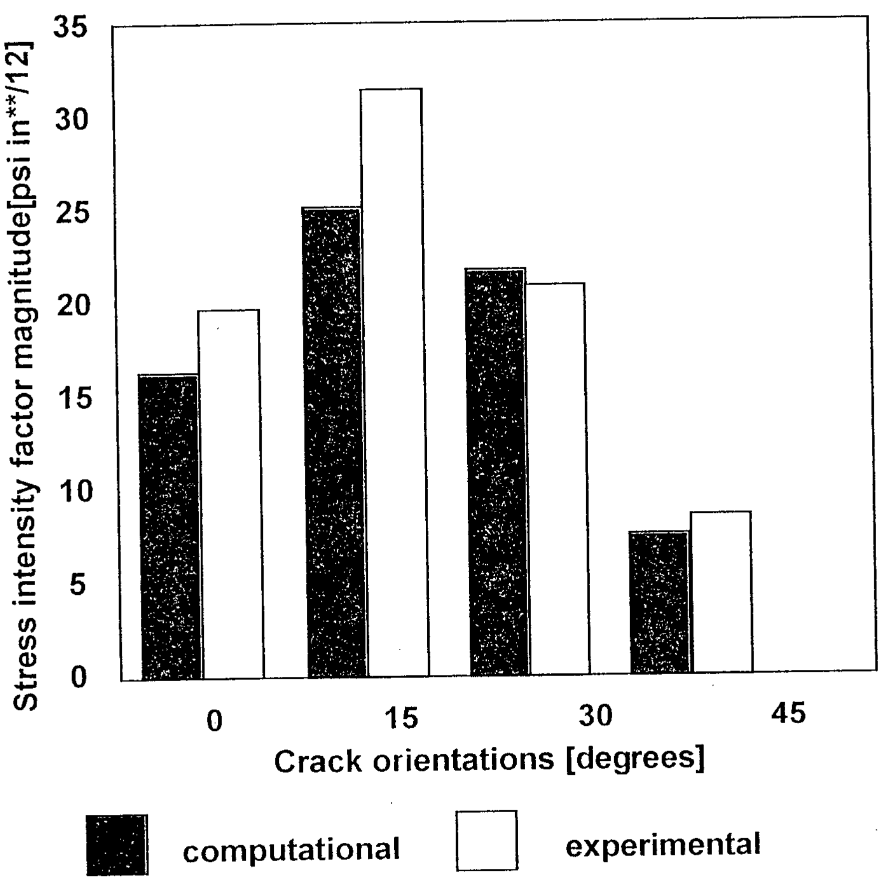


Contour Plot of Maximum In-Plane Shear Stress Component for Various Mode Mixities

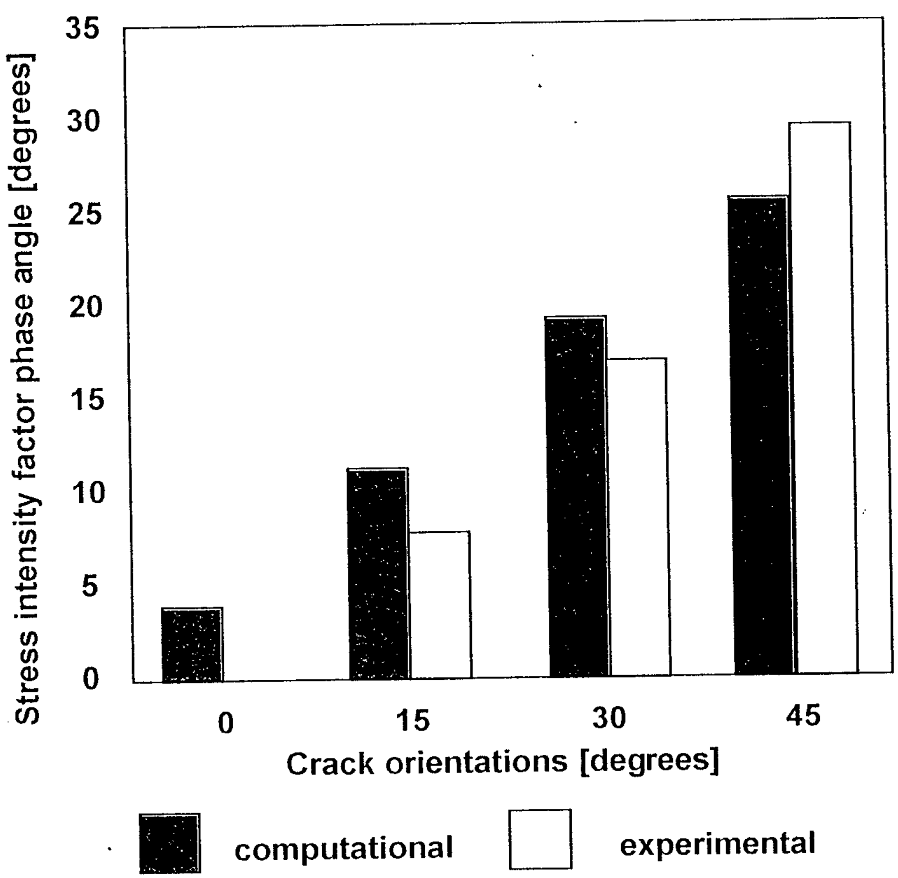


Results

Magnitude of Complex Stress Intensity Factors



Phase Angle of Complex Stress Intensity Factors



Conclusions

- Area integration and bond line traction regression is a simple and accurate way of determining the magnitude and phase angle of K for cracks along the interfaces between two incompressible materials under plane strain conditions.

Acknowledgements

- Experimental results and data - Dr. C.W. Smith, Virginia Polytechnic Institute and State University

- Funding and Computational Facilities - Dr. C.T. Liu, Air Force Research Laboratory, Edwards Air Force Base, California