

201

<sup>7</sup>LiF AND CaF<sub>2</sub>:Mn EXPERIMENTAL DATA FOR  
EVALUATING TLD ENERGY RESPONSE THEORY

by

Robert Mark Ostmeyer

B.S., Kansas State University, 1979

---

A MASTER'S THESIS

submitted in partial fulfillment of the  
requirements for the degree

MASTER OF SCIENCE

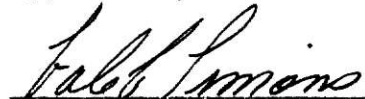
Department of Nuclear Engineering

KANSAS STATE UNIVERSITY

Manhattan, Kansas

1980

Approved by:



Major Professor

Spec. Coll.  
LD  
2.668  
.T4  
1980  
078  
c.2

TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES . . . . .	.iii
LIST OF FIGURES . . . . .	v
1.0 INTRODUCTION . . . . .	1
1.1 History of Method Development and Evaluation. . . . .	1
1.2 Scope of Experimentation. . . . .	2
2.0 EXPERIMENTAL EQUIPMENT AND MATERIALS . . . . .	3
2.1 TLD Response Measurement Equipment. . . . .	3
2.2 Annealing Equipment . . . . .	5
2.3 Handling Equipment. . . . .	7
2.4 Thermoluminescent Dosimeters. . . . .	7
2.5 Encasement Materials. . . . .	8
2.6 Gamma Ray Sources . . . . .	8
2.7 Irradiation Device. . . . .	15
3.0 EXPERIMENTAL PROCEDURES. . . . .	19
3.1 TLD Handling. . . . .	19
3.2 TLD Preannealing. . . . .	19
3.3 TLD Calibration . . . . .	20
3.4 TLD Encapsulation . . . . .	20
3.5 Exposure/Wait/Response Measurement Schedule . . . . .	23
3.6 TLD Response Measurement Procedure. . . . .	24
3.7 Sensitivity Selection . . . . .	28
4.0 EXPERIMENTAL RESULTS . . . . .	35
4.1 TLD Energy Response Results . . . . .	35
4.2 Sleeve Thickness Effects Results. . . . .	41
5.0 THEORETICAL CONSIDERATIONS . . . . .	55
5.1 The Dose Ratio Factor . . . . .	55
5.2 The Calculated Dose . . . . .	55
5.3 Relative Source Counts. . . . .	61
5.4 Sleeve Wall Attenuation Considerations. . . . .	61
6.0 SLEEVE WALL ATTENUATION OF PRIMARY GAMMAS. . . . .	70
6.1 The Effective Attenuation Coefficient . . . . .	70
6.2 Attenuation Corrected TERC/III Calculations . . . . .	73
7.0 COMPARISON OF EXPERIMENT AND THEORY. . . . .	92
7.1 Calculated and Experimental TLD Doses . . . . .	92
7.2 Comparison of Attenuation Corrected Doses . . . . .	97
7.3 The Effective Source Counts Comparison. . . . .	97
8.0 CONCLUSIONS. . . . .	.113

## Table of Contents - Continued

	<u>Page</u>
9.0 SUGGESTIONS FOR FURTHER STUDY. . . . .	115
REFERENCES. . . . .	117
ACKNOWLEDGEMENTS. . . . .	119
APPENDIX A: Statistics Equations for Data Reduction. . . . .	120
APPENDIX B: TERC/III Input and Output. . . . .	125
APPENDIX C: Raw TLD Data . . . . .	143
APPENDIX D: Ionization Theory . . . . .	193

**THIS BOOK  
CONTAINS  
NUMEROUS PAGES  
WITH THE ORIGINAL  
PRINTING BEING  
SKEWED  
DIFFERENTLY FROM  
THE TOP OF THE  
PAGE TO THE  
BOTTOM.**

**THIS IS AS RECEIVED  
FROM THE  
CUSTOMER.**

## LIST OF TABLES

<u>Table</u>		<u>Page</u>
2.1	Encasement materials used during measurement of the energy response of encased $^7\text{LiF}$ and $\text{CaF}_2\text{:Mn}$ TLDs. . . . .	10
2.2	Encasement materials used during measurement of the wall thickness effect on the energy response of encased $^7\text{LiF}$ and $\text{CaF}_2$ TLDs . . . . .	11
2.3	Gamma-ray sources purchased for use in the TLD energy response and sleeve thickness studies. . . . .	16
3.1	Analyzer settings used for the response measurement of the $^7\text{LiF}$ and $\text{CaF}_2\text{:Mn}$ TLDs . . . . .	25
4.1	TLD analyzer output normalized to iron encased $^7\text{LiF}$ TLDs from a precision subset . . . . .	36
4.2	TLD analyzer output normalized to iron encased $\text{CaF}_2\text{:Mn}$ TLDs from a precision subset. . . . .	37
4.3	TLD analyzer output normalized to iron encased $^7\text{LiF}$ TLDs corrected for individual sensitivity. . . . .	
4.4	TLD analyzer output normalized to iron encased $\text{CaF}_2\text{:Mn}$ TLDs corrected for individual sensitivity . . . . .	40
5.1	Calculated TLD dose ratios for encased $^7\text{LiF}$ TLDs derived from TERC/III results with iron encased TLDs as the normalizing values. . . . .	59
5.2	Calculated TLD dose ratios for encased $\text{CaF}_2\text{:Mn}$ TLDs derived from TERC/III results with iron encased TLDs as the normalizing values. . . . .	60
6.1	Effective attenuation coefficients for encased $^7\text{LiF}$ TLDs calculated with sleeve curvature corrections to the sleeves and with TLD readouts corrected for individual sensitivity. . . . .	71
6.2	Effective attenuation coefficients for encased $\text{CaF}_2\text{:Mn}$ TLDs calculated with sleeve curvature corrections to the sleeves and with TLD readouts corrected for individual sensitivity. . . . .	72
6.3	Calculated TLD dose ratios for encased $^7\text{LiF}$ TLDs derived from attenuation corrected TERC/III results with iron encased TLDs as the normalizing values. . . . .	90

## List of Tables - Continued

<u>Table</u>		<u>Page</u>
6.4	Calculated TLD dose ratios for encased $\text{CaF}_2:\text{Mn}$ TLDs derived from attenuation corrected TERC/III results with iron encased TLDs as the normalizing values. . . . .	91
7.1	Comparison of dose ratios using encapsulated $^7\text{LiF}$ TLDs from a precision subset. . . . .	93
7.2	Comparison of dose ratios using encapsulated $\text{CaF}_2:\text{Mn}$ TLDs from a precision subset. . . . .	94
7.3	Comparison of dose ratios using encased $^7\text{LiF}$ TLDs where the experimental values were corrected for the sensitivity of individual TLDs. . . . .	95
7.4	Comparison of dose ratios using encased $\text{CaF}_2:\text{Mn}$ TLDs where the experimental values were corrected for the sensitivity of individual TLDs. . . . .	96
7.5	Comparison of $^7\text{LiF}$ dose ratios where the experimental values were corrected for sensitivity and the calculations were corrected for sleeve wall attenuation. . .	99
7.6	Comparison of $\text{CaF}_2:\text{Mn}$ dose ratios where the experimental values were corrected for sensitivity and the calculations were corrected for sleeve wall attenuation. . .	100