AD-A062 450 NAVAL RESEARCH LAB WASHINGTON D C F/G 7/4

INTEGRAL REFLECTION COEFFICIENTS, R, FOR CURVED AND GROUND LIF --ETC(U)

NOV 78 L S BIRKS, J W SANDELIN, D B BROWN

UNCLASSIFIED NRL-MR-3880 NL

1 OF 1

AD A062450

END

DATE FILMED

3-79

DDC

NRL Memorandum Report 3880

Integral Reflection Coefficients, R, for Curved and Ground LiF and ADP

L.S. BIRKS, J.W. SANDELIN and D.B. BROWN

X-Ray Optics Branch
Radiation Technology Division

November 29, 1978

NAVAL RESEARCH LABORATORY
Washington, D.C.

(14) NRL-MR-3880

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER NRL Memorandum Report 3880	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) INTEGRAL REFLECTION COEFFICIENTS, R, FOR CURVED AND GROUND LiF AND ADP		5. TYPE OF REPORT & PERIOD COVERED (9) Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) L. S. Birks, J. W. Sandelin and D.B. Brown		8. CONTRACT OR GRANT NUMBER(s) M.I.T. P.O. # SC27006 Account No. 86821 Requisition No. 32567
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Research Laboratory Washington, D.C. 20375		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NRL Problem P04-04F
11. CONTROLLING OFFICE NAME AND ADDRESS (11)		12. REPORT DATE 29 November 20, 1978
		13. NUMBER OF PAGES 10
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) (12) 10p.		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

X-ray spectra
Curved-crystal
X-ray diffraction

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Integral reflection coefficients, R, were measured for flat and curved crystals of LiF and ADP to determine whether or not curving degraded their diffracting power. There was, in fact, an increase in measured R values for the curved crystals except for 2nd order diffraction of Cr radiation from ADP which decreased by 10%. Theoretical R values were calculated for all of the experimental situations and showed good agreement on an absolute as well as a relative basis.

DD FORM 1473 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

251 950

INTEGRAL REFLECTION COEFFICIENTS, R, FOR CURVED AND GROUND LiF AND ADP

INTRODUCTION

The objective of the work was to demonstrate that curved and ground crystals of LiF (200) and ADP (101) can be prepared without degrading the integral reflection coefficient, R, (diffracting efficiency) compared to flat crystals.

MATERIAL PREPARATION MEASUREMENTS, AND CALCULATIONS

LiF

Blanks 1 × 5 cm by 0.15 cm thick were cleaved from Harshaw material. Fig. 1a illustrates a topograph of the as-cleaved material. The R values at Cu Kα for the cleaved material were measured on the parallel-beam optics already described (1). R ranges from 3.57×10^{-5} to 5.26×10^{-5} which is typical of good LiF (2).

Next, one of the blanks ($R = 3.57 \times 10^{-5}$) was curved plastically to 40 cm radius and then ground to 20 cm radius. Fig. 1b is a topograph of the curved and ground crystal. There are some variations in diffracted intensity in Fig. 1b but no apparent flaws or misoriented regions.

Note: Manuscript submitted October 13, 1978.

Fig. 2a and b show the focusing of the crystal at crossover. Fig. 2a is with the crystal set at the maximum intensity for 1st order diffraction of Cu Kα radiation. It shows resolution of the $K\alpha_1$, $K\alpha_2$ doublet indicating accurate curving and grinding. In Fig. 2b the crystal was rocked over a range of 4 degrees 2θ during exposure. It still shows the $K\alpha_1$, $K\alpha_2$ separation and is a further indication that there are no misoriented regions in the crystal, i.e. that the curving and grinding are accurate.

Finally the curved-crystal R value was measured with a divergent-beam focusing geometry. This R value was 8.42×10^{-4} which cannot be compared with the flat cleaved-crystal value because the plastically curved crystal is mosaic. It does fall satisfactorily within the calculated range of curved-crystal R values, i.e. 3.5×10^{-4} for minimum imperfection and 9.8×10^{-4} for ideally mosaic.

<u>ADP</u>

A boule of ADP was sawed into blanks the same size as for LiF. Fig. 3a shows a topograph of one of the blanks and again, as for the LiF, it indicates uniform diffraction. R values for the flat ADP at Cr Kα were 6.78×10^{-5} for the as-sawed material and 5.7×10^{-5} for a blank after some waster polishing. (A calculated value for perfect ADP is 3×10^{-5}.)

ADP is a very fragile material mechanically and also is sensitive to thermal shock. Details of the preparation of a curved and ground ADP will not be discussed except to say that the curving is elastic. Fig. 3b is a topograph (3rd order of Cu Kα) of the curved and ground ADP. There is one darker line which corresponds to a visible crack in the crystal but the intensity is uniform except for that.

Fig. 4a and b show the crossover of the diffracted radiation (again 3rd order Cu Kα) and should be compared to Fig. 2a and b for LiF. The resolution of ADP is slightly better than for LiF as would be expected because the elastically curved ADP corresponds to an essentially perfect crystal whereas the LiF is mosaic due to plastic dislocations.

The R value for the curved ADP was measured in two ways. First, it was measured in a region about 1 × 1 cm by rocking the crystal through the diffracting angle on the parallel-beam optics used for measuring flat crystals (1st order Cr Kα). This R value was 7.01×10^{-5} compared to 6.38×10^{-5} for the flat as-sawed blank and to 9.6×10^{-5} calculated for curved ADP. Second, the R value was measured with a divergent beam in focusing geometry but with 2nd order Cr Kα. It was necessary to go to 2nd order diffraction for the divergent beam measurement because of the larger d-spacing compared to LiF and the geometry of the divergent-beam apparatus. The curved and ground R value for 2nd order Cr Kα was 1.18×10^{-5}. To compare this with a flat crystal it was necessary to remeasure a flat as-sawed blank in the 2nd order diffraction; this gave a value of 1.28×10^{-5} which compares satisfactorily with the curved crystal R value and with a calculated R value of 1.6×10^{-5} for the 2nd order diffraction.

CONCLUSIONS

All of the measurements and calculations for curved and ground LiF and ADP indicate that there is no degradation of flat-crystal R values if the crystal preparation is carried out properly. Table I summarizes comparative R values.

In addition the measurements indicate that there is no degradation of resolution for properly curved and ground crystals. This was demonstrated by the separation of the $K\alpha_1$, $K\alpha_2$ doublet with the curved and ground crystals (1st order Cu $K\alpha$ for LiF and 3rd order Cu $K\alpha$ for ADP).

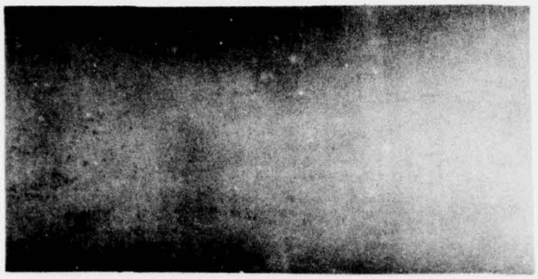
REFERENCES

(1) J. V. Gilfrich, D. B. Brown, P. G. Burkhalter, Appl. Spectros. 29, 322 (1975).

TABLE I. R-Values for LiF and ADP

		Measured	Calculated
LiF (200)	flat, cleaved	3.6×10^{-5}	3.4×10^{-5}
Cu Kα	curved, abraded	8.0×10^{-4}	3.5×10^{-4} minimum imperfection
			9.8×10^{-4} ideally mosaic
ADP	(101) flat	6.8×10^{-5}	6.2×10^{-5}
Cr Kα	curved	7.0×10^{-5}	9.3×10^{-5}
	(202) flat	1.3×10^{-5}	1.3×10^{-5}
	curved	1.2×10^{-5}	1.6×10^{-5}

LiF

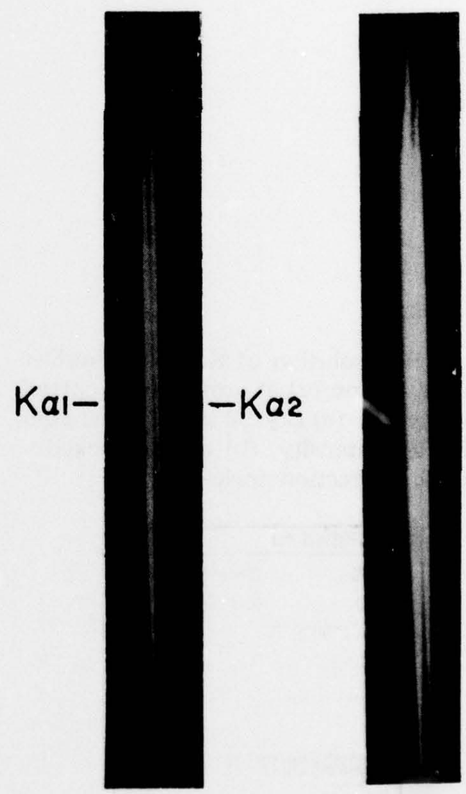


(a)

(b)

Fig. 1 — (a) Topograph of cleaved, flat LiF crystal; Cu Kα, 1st order, (b) topograph of curved and ground LiF crystal, Cu Kα, 1st order

Fig. 2 — Resolution of $K\alpha_1$ $K\alpha_2$ doublet (Cu Kα, 1st order) at crossover of curved LiF crystal. (a) Crystal set for maximum diffracted intensity, (b) crystal rocked through diffraction angle.



ADP

(a) (b)

Fig. 3 — (a) Topograph of sawed, flat ADP crystal; Cu Kα, 3rd order, (b) topograph of curved and ground ADP crystal; Cu Kα, 3rd order

(a) (b)

Fig. 4 — Resolution of $K\alpha_1$ $K\alpha_2$ doublet (Cu Kα, 3rd order) at crossover of curved ADP crystal. (a) Crystal set for maximum diffracted intensity, (b) crystal rocked through diffraction angle.