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Mössbauer Study of Fe^{57} in FeTi and $Fe_{.8}Mn_{.2}Ti$ Hydrides

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12/16/81

U.S. ARMY RESEARCH OFFICE

DAA G29 80 G 0003

MORGAN STATE UNIVERSITY

REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): MÖSSBAUER STUDY OF Fe^{57} IN FeTi AND $Fe_{.8}Mn_{.2}Ti$ HYDRIDES	5. TYPE OF REPORT & PERIOD COVERED: Final 9/10/80 - 9/9/81
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Frederick Oliver; Windsor Morgan	8. CONTRACT OR GRANT NUMBER(s): DAAG29-80-G-0003
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Morgan State University, Dept. of Physics, Baltimore, Maryland 21239	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: P-17711-H-P
11. CONTROLLING OFFICE NAME AND ADDRESS: U. S. Army Research Office, Post Office Box 12211, Research Triangle Park, NC 27709	12. REPORT DATE: 12/16/81
	13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	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)

NA

18. SUPPLEMENTARY NOTES

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

Mössbauer
Hydrides
FeTi
$Fe_{.8}Mn_{.2}Ti$

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

This study has been conducted to investigate the effect hydriding has on the electronic and magnetic properties of FeTi and $Fe_{.8}Mn_{.2}Ti$ using the Mössbauer Effect. Experiments were conducted using the 14.4 kev Mössbauer radiation from Fe^{57} at

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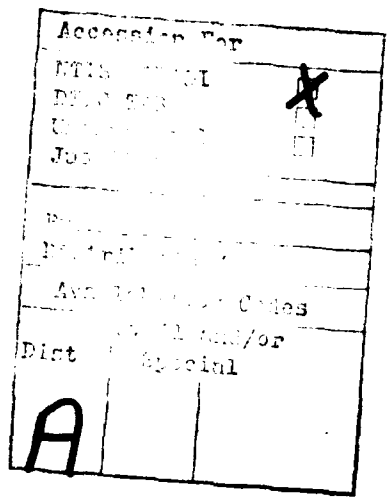
temperatures between 4.2°K and 298°K. Studies were made of the changes in isomer shift and linewidth upon hydriding. Our results indicate that hydriding FeTi and $Fe_{.8}Mn_{.2}Ti$ causes phase changes in the crystals from an α phase to either a β and/or γ phase. These studies also indicate that although there is a major change in the pressure composition isotherm upon alloying with manganese, there is no change in the electronic structure of the iron.



STATEMENT OF PROBLEM

This research was a Mössbauer study of FeTi and $Fe_{.8}Mn_{.2}Ti$ and their hydrides. Fe^{57} was used as a probe in studying the metallurgical and electronic structure of the compounds studied. Changes in electronic density were indicated by changes in isomer shift. Experiments were conducted at various temperatures between room temperature and liquid helium ($4.2^{o}K$). A computer least squares analysis was performed on all spectra to determine the best theoretical fit for all experimental data. An interpretation of the effects of hydrogen absorption in intermetallics was made by comparing X-ray diffraction and Mössbauer spectra before and after hydriding for FeTi and $Fe_{.8}Mn_{.2}Ti$.

SUMMARY OF RESULTS

X-ray diffraction measurements indicated that $Fe_{.8}Mn_{.2}Ti$ was single phase with the identical pattern found for FeTi. Mössbauer measurements on FeTi gave the same isomer shift within experimental error as found by previous researchers. FeTi and $Fe_{.8}Mn_{.2}Ti$ exhibited a single peak and remained non-magnetic down to 4.2°K. Spectra rendered identical results within experimental error for FeTi and $Fe_{.8}Mn_{.2}Ti$ (See Table 1).

Our results indicate that hydriding FeTi and $Fe_{.8}Mn_{.2}Ti$ causes phase changes in the crystals. These studies indicate that although there is a major change in the pressure composition isotherms upon alloying with manganese, there is no change in the electronic structure of the iron atom as demonstrated by the Mössbauer Effect. There appears to be no correlation between electron structure due to the 3rd element and the hydrogen absorption properties.

Hydriding broadens the linewidth for both compounds. This broadening is attributed to changes in phase of the compounds. There was an increase in the isomer shift. The change represents a decrease in the s-electron density at the nuclear site. A reduction of the electron density may be due to either an increase of d character at the Fe site or an increase in the lattice volume.

Mössbauer measurements on cycled samples showed the compounds to be reversible (see table 2) with fully desorbed samples rendering the same spectra as unhydrided compounds. Cycled samples showed no evidence of ferromagnetic precipitates.

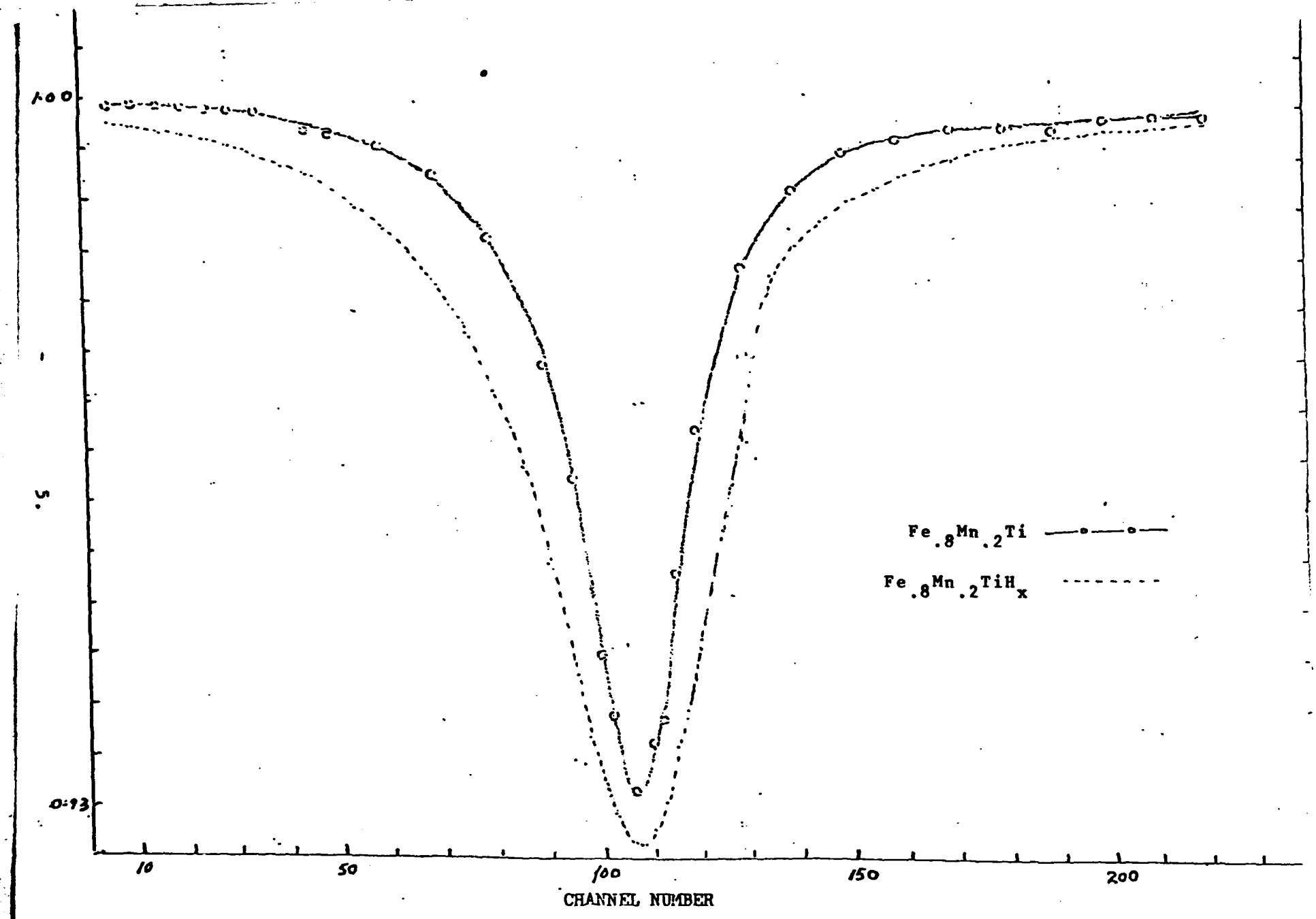
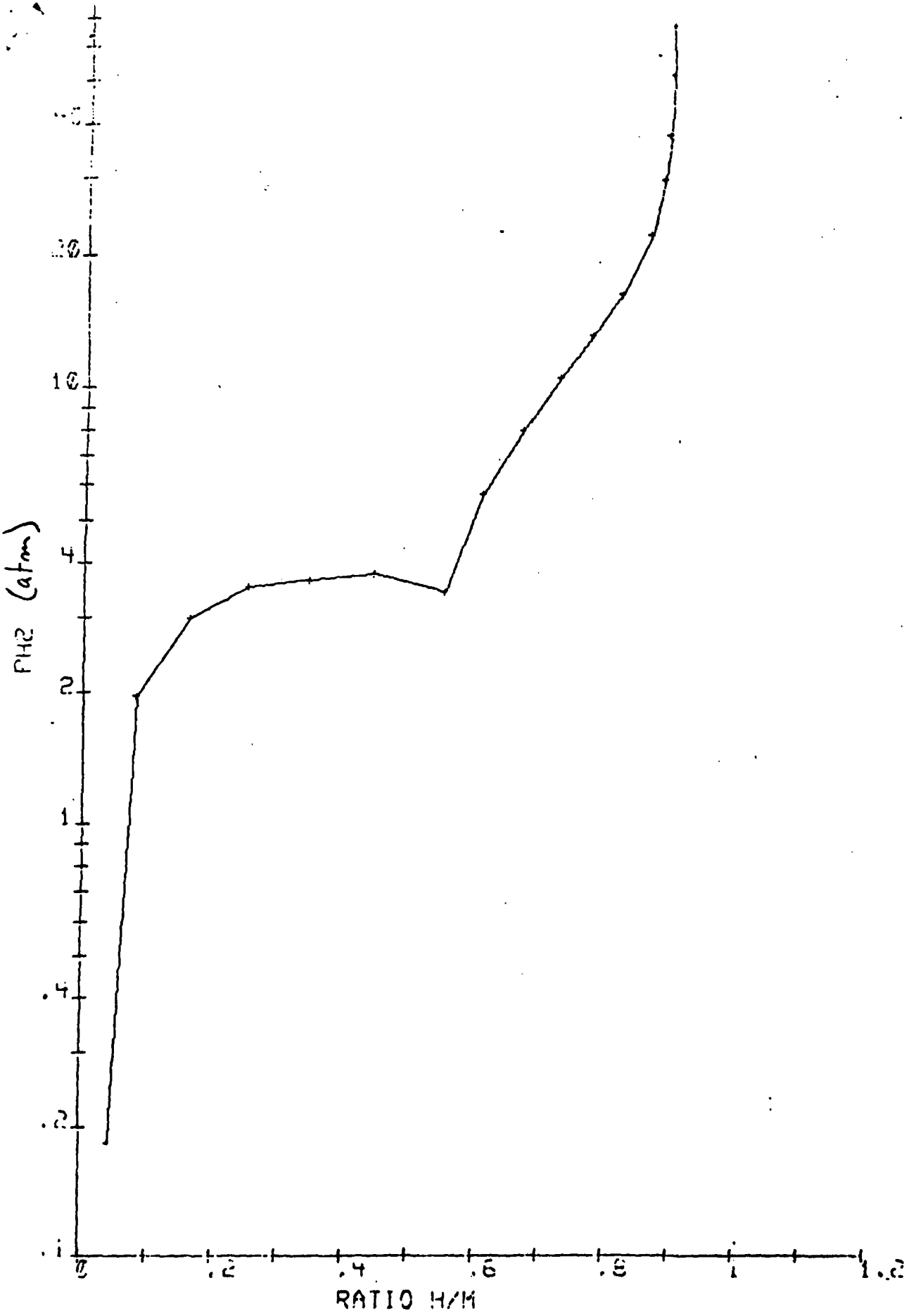
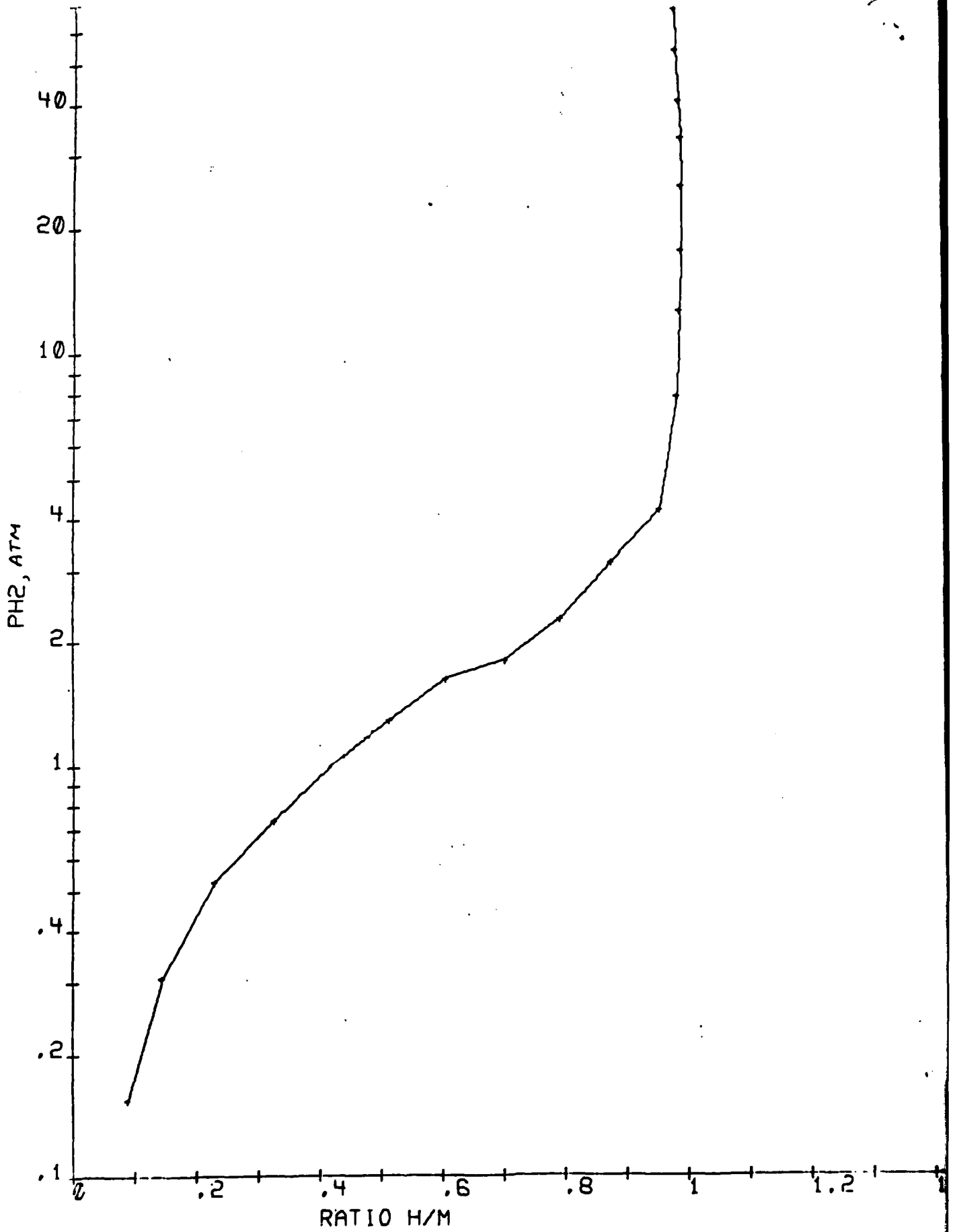


FIG. 1 Mössbauer Spectra of $Fe_{.8}Mn_{.2}Ti$ and $Fe_{.8}Mn_{.2}TiH_x$



PRESSURE COMPOSITION ISOTHERM FOR $FeTiH_x$



PRESSURE COMPOSITION ISOTHERM FOR $Fe_{.8}Mn_{.2}TiH_x$

SAMPLE	LINEWIDTH(mm/sec)
FeTi	.20 ± .01
$FeTiH_x$	.26
$Fe_{.8}Mn_{.2}Ti$	.22
$Fe_{.8}Mn_{.2}TiH_x$	.25

Table 1. - Comparison of *Mössbauer Linewidth* for Hydrided FeTi and $Fe_{.8}Mn_{.2}Ti$.

SAMPLE	ISOMER SHIFT
FeTi	.16 ± .01
$Fe_{.8}Mn_{.2}Ti$	.15
$Fe_{.8}Mn_{.2}TiH_{x-x}$ (Hydrogen cycled)	.14

Table 2. - Comparison of Mössbauer Isomer Shift Data (295°K)

SAMPLE	TEMPERATURE	ISOMER SHIFT
FeTi	295°K	-.16 ± .01
FeTi	77°K	-.05
FeTi	4.2°K	-.03

Table 3. - Comparison of Mössbauer Isomer Shift with Temperature for FeTi.

Thesis Research Supported under grant No. DAA G29 80 G 0003

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Mössbauer Study of Fe in FeTi and $Fe_{.8}Mn_{.2}Ti$

Master of Science - Kim Fraunfelker
Mössbauer Effect Study of $TiFe_{.8}Mn_{.2}H_x$

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