

AD-A147 718

COLLISIONAL ENERGY EXCHANGE IN POLYATOMIC MOLECULES(U)

1/1

YALE UNIV NEW HAVEN CT DEPT OF CHEMICAL ENGINEERING

S B RYALI ET AL 30 DEC 83 AFOSR-TR-84-0901

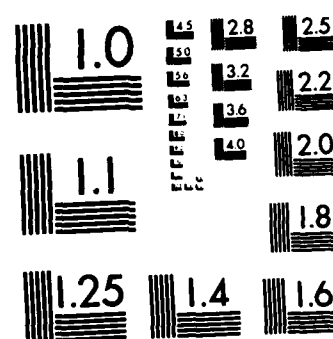
UNCLASSIFIED

F49620-83-K-0017

F/G 20/8

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

12

FINAL REPORT

to the

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

Directorate of Chemical Sciences

Contract # F49620-83-K-0017

on

Collisional Energy Exchange in Polyatomic Molecules

by

S. B. Ryali and J. B. Fenn, Principal Investigators

Department of Chemical Engineering
Yale University
PO Box 2159 YS
New Haven, CT 06520

30 December 1983

DTIC
SELECTE
NOV 21 1984
A

Approved for public release;
distribution unlimited.

AD-A147 710

DTIC FILE COPY

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AFOSR-TR. 84-0901	2. GOVT ACCESSION NO. A147710	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) COLLISIONAL ENERGY EXCHANGE IN POLYATOMIC MOLECULES		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) S. B. Ryali and J. B. Fenn		8. CONTRACT OR GRANT NUMBER(s) F49620-83-K-0017 (continued) F49620-83-K-0026
9. PERFORMING ORGANIZATION NAME AND ADDRESS Yale University Department of Chemical Engineering New Haven, CT 06520-2159		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 61102F 2303/81
11. CONTROLLING OFFICE NAME AND ADDRESS Chemical & Atmospheric Sciences AFOSR/NC Bolling Air Force Base, D. C. 20332-6600		12. REPORT DATE 30 December 1983
		13. NUMBER OF PAGES 5
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)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Free Jets, Fourier Transform Spectrometry Infrared Spectrometry Rotational Energy Distributions Surface Energy Accommodation Surface Catalyzed Reactions Molecular Energy Exchange Collisional Energy Exchange Gas-Surface Interactions Carbon Dioxide Carbon Monoxide		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Fourier Transform Infrared Spectrometry (FTIS) has been used to study several kinds of gas-gas and gas-surface collision processes brought about with and in supersonic free jets in vacuo. Following are some key results: (1) Terminal distributions of rotational energy in free jets of CO and CO₂ show a non-Boltzmann distribution that can be characterized by a two-temperature model and explained in terms of competition between rotation-rotation and rotation-translation transfers. (2) Spectra of CO₂ molecules excited by collisions with N₂ molecules indicated similar two-temperature distributions, possibly due		

DD FORM 1473
1 JAN 73

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Approved for public release;
distribution unlimited.

Nitrogen

20.

to secondary collisions between excited CO_2 and N_2 . (3) The accommodation of vibrational and rotational energy during collisions between CO , CO_2 and NO molecules and hot platinum surfaces has been determined over a range of surface temperatures. (4) Excess internal energies have been determined in nascent CO and CO_2 molecules formed respectively by catalytic oxidation of C and CO on a platinum surface. An energy balance indicates that about $1/3$ of the available reaction energy is absorbed by the surface, the remainder going mostly into vibrational modes of product molecules.

Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
Distribution/	
Availability Codes	
Avail and/or	
Special	
A	

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

I. Introduction

For the past three years under this grant we have been pursuing a program of research relating to the details of energy exchange processes during collisions between molecules in the gas phase and between molecules and surfaces. This research has been characterized by a combination of methods based on supersonic free jet expansions in vacuo and molecular beam methods with spectroscopy. In particular, we use supersonic free jets expanding into vacuo to bring about the collisions and Fourier Transform Infrared Spectrometry to determine the states of one or both collision partners before and/or after the encounter. In what follows we will set forth briefly what we have been able to accomplish in each of the several topics that we have investigated.

II. Achievements and Results

Reference is made to the Final Technical Report on Contract F49620-80-C-0026 that was submitted three months ago on 21 August 1983. It contained a complete account of our achievements during the period from 1 October 1979 to 21 August 1983. The first three years of that period were under Grant No. F49620-80-C-0026. A one-year grant (No. F49620-83-K-0017) was the instrument for the final year that ended 31 December 1983. This report is the final report on the latter grant. Because the above-mentioned report covered all results up to 21 August 1983, this report covers only the period from 21 August 1983 to 30 December 1983.

During that last four months we continued our time-resolved surface scattering studies of CO oxidation on a platinum surface. We were able to increase the resolution to about 15 microseconds from the 45 microseconds

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFSC)
NOTICE OF TRANSMITTAL TO DTIC

- 1 This technical report has been reviewed and is approved for public release IAW AFR 190-12. Distribution is unlimited.

MATTHEW J. KERPNER
Chief, Technical Information Division

achieved in the first experiments. There is much information to be extracted from these time-resolved spectra and we are busily engaged in analyzing the data. What clearly emerges thus far in the case of platinum is that the rotational envelope of the nascent CO_2 product molecules is substantially narrower when the surface coverage of oxygen is low. In other words, the rotational "temperature" of the produce molecules is lower when there is less oxygen on the surface. In the case of a palladium surface, on the other hand, there was no difference in rotational "tempeature" as the oxygen coverage of the surface changed. We do not yet understand the implications of these observations. We hope to continue the experiments and to decipher what they are trying to tell us.

There have been no further publications during this four-month period.

END

FILMED

12-84

DTIC