Our earlier studies of molecule-surface CID were extended to the case of NO2, which has been implicated as the emitting species in shuttle glow phenomena. The glow is believed to derive from the recombination of NO and atomic oxygen, yielding internally excited NO2. Because the NO2 zeroth order 2B2 excited state is strongly coupled to the 2A1 ground state, levels formed in recombination reactions emit throughout the visible. In our experiments, the reverse process was examined. Namely, NO2 entrained in a molecular beam was directed at a crystal surface and was photoexcited 2 cm (10 ms) before reaching the surface. The incident molecules had enough internal plus translational energy to undergo CID, which was observed for a range of NO2 internal excitations. Unexcited NO2 yielded no signal. Additionally, NO was detected with state and angular resolution and it was shown that products were scattered preferentially in the specular direction, ruling out a long residence time on the surface. It is most likely that NO2 decomposes rapidly following impact with the surface, in accord with k(E) measurements that indicate subpicosecond lifetimes for excess energies ~500 cm⁻¹. This was the first demonstration of such an effect and supports the thesis that NO2 is responsible for the shuttle glow.
AIR FORCE OFFICE OF SCIENTIFIC RESEARCH - AASERT SUPPLEMENT  
(Grant No. F49620-92-J-0230)  
ANNUAL TECHNICAL AND EVALUATION REPORT  
May 1993 - April 1994  

PARENT AFOSR AWARD: Grant No. F49620-92-J-0168  

GAS-SURFACE INTERACTIONS NEAR DISSOCIATION THRESHOLD

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94-31010  
94 9 28 048
Technical Report:

Our earlier studies of molecule-surface CID were extended to the case of NO₂, which has been implicated as the emitting species in shuttle glow phenomena. The glow is believed to derive from the recombination of NO and atomic oxygen, yielding internally excited NO₂. Because the NO₂ zeroth order 2B₂ excited state is strongly coupled to the 2Δ₁ ground state, levels formed in recombination reactions emit throughout the visible. In our experiments, the reverse process was examined. Namely, NO₂ entrained in a molecular beam was directed at a crystal surface and was photoexcited 2 cm (10 ms) before reaching the surface. The incident molecules had enough internal plus translational energy to undergo CID, which was observed for a range of NO₂ internal excitations. Unexcited NO₂ yielded no signal. Additionally, NO was detected with state and angular resolution and it was shown that products were scattered preferentially in the specular direction, ruling out a long residence time on the surface. It is most likely that NO₂ decomposes rapidly following impact with the surface, in accord with k(E) measurements that indicate subpicosecond lifetimes for excess energies > 500 cm⁻¹. This was the first demonstration of such an effect and supports the thesis that NO₂ is responsible for the shuttle glow.

In addition, recent FTIR spectroscopy of CINO adsorbed on MgO(100), suggest that CINO aggregates on the surface in a way that affects photon-induced processes.

The progress of the students, James Brandon and James Singleton, in their course-work as well as other requirements of the Ph.D. program is satisfactory.

Evaluation Report

The parent award number to which the AASERT students are linked is F49620-92-J-0168. The amount of funding of the parent award for the period 12/01/93 - 11/30/94 is $175,000 and one (1) graduate student was supported under the said award prior to and after the AASERT award. The amount of funding under the AASERT program for the period 05/01/92 - 04/30/95 is $94,091 ($31,364 per year) and two (2) graduate students (above-mentioned names) were partially supported under this award for the period 05/01/93 - 04/30/94.

This is to certify that James Brandon and James Singleton are United States citizens. Verification was made through presentation of their birth certificates stating their birthdates and birthplaces, as well as their social security numbers.