

# Abstract: Isothermal ramped field desorption of benzene from tungsten

J. A. Panitz

Sandia Laboratories, Albuquerque, New Mexico 87185

(Received 3 November 1978)

PACS numbers: 79.70. + q

The binding of molecular benzene (at 78 K) on clean, tungsten surfaces have been investigated as a function of electric field strength using a new ramped field-desorption technique.<sup>1,2</sup> In this technique, a tungsten field-ion specimen "tip" cleaned by field evaporation (at  $\approx 5.7$  V/Å), and characterized by helium field-ion microscopy (at  $\approx 4.5$  V/Å), is subjected to a linearly increasing electric field following benzene adsorption from the gas phase. The rate of field-induced desorption of surface species (as positive ions) is plotted as a function of applied field on an  $x$ - $y$  recorder, producing spectra remarkably similar in appearance to those produced by thermal desorption at zero desorption at zero field.

In the ramped desorption spectra of benzene, three prominent, reproducible features can be identified, including: (1) a low field (0.32 V/Å) feature which grows continuously with benzene exposure and is associated with physically adsorbed benzene multilayers; (2) a sharp peak at 0.36 V/Å which grows with benzene exposure until a saturation coverage is reached (representing another binding state of physically adsorbed benzene at the surface) and, (3) a series of poorly resolved peaks between  $\approx 0.38$  and 1.13 V/Å which grow with benzene exposure up to some maximum dosage, and are associated with a monolayer of chemisorbed benzene on the surface. Dissociation of molecular benzene within the first physically adsorbed layer and within the chemisorbed layer appears to be highly probable. Imaging Atom-Probe

analysis shows that dissociation within the chemisorbed layer results in the production of a tightly bound carbonaceous layer on the surface which is only desorbed at fields approaching 3.8 V/Å. No evidence is seen for the dissociation of molecular benzene within the outermost physically adsorbed multilayers at 78 K, since only the molecular ion  $C_6H_6^+$  ( $m/n = 78$ ), and a small abundance of  $C_6H_6^{2+}$  ( $m/n = 39$ ) is seen.

By photographically recording the impact of individual field-desorbing species over the field ranges corresponding to the distinct features of the ramp spectra, the distribution of the species on the surface which produced these features were obtained with angstrom resolution. The resulting "ramped-desorption images" show developing areal uniformity in the physisorbed benzene multilayer as a function of benzene dosage, but crystallographic specificity only within the chemisorbed layer. From such images it was concluded that benzene migration (with or without an applied electric field) is negligible at 78 K.

**Acknowledgment:** Research was sponsored by the U.S. Department of Energy under Contract AT(29-1)789.

<sup>a</sup>) A U.S. Department of Energy facility.

<sup>1</sup>) J. A. Panitz, The 25th Int'l. Field-Emission Symposium, Albuquerque New Mexico (July 1978).

<sup>2</sup>) J. A. Panitz, J. Vac. Sci. Technol. (to be published).