This Week's Citation Classic

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Baker J M & Eastman D E. Photoemission spectra from adsorbed O on W(l10) and CO on W(100). *J. Vac. Sci. Technol.* **10**:223-6, 1973.
[IBM, Thomas J. Watson Research Center, Yorktown Heights, NY]

Ultraviolet photoemission spectroscopy is used to study the electronic structure of well characterized adsorbate structures on tungsten. The UPS spectra indicate that oxygen adsorbs as a single phase on W(110). Spectra from CO on W(100) suggest that CO adsorbs initially in dissociated form and subsequently in a molecular form. [The *SCI*® indicates that this paper has been cited over 95 times since 1973.]

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"In the early days of ultraviolet photoemission spectroscopy it was realized that the surface sensitivity of the technique made it possible to obtain spectra showing the electronic levels of submonolayer quantities of adsorbed gases.[13] At this time, a wide variety of structures of gases adsorbed on single crystal surfaces had been studied using techniques such as low energy electron diffraction (LEED), flash desorption, or work function studies. A single gas adsorbed on a single surface plane of a metal would often result in several different structures, depending on the amount of gas adsorbed or the thermal history of the sample. For example, at least three different states of CO on W(100) were known. The models proposed to explain an adsorbate structure often involved distinctly different configurations for the bonding between the gas and the substrate. It appeared that the electronic information provided by UPS could be valuable in distinguishing between various bonding configurations.

"This potential was evident to Dean Eastman as a consequence of his experiments with adsorption on deposited films[12] so he encouraged me to join him, since my thesis work had involved surface studies. We had the good fortune of being able to obtain the LEED system which Franco Jona had used for his early LEED studies. To this we added an He-Ne resonance lamp from Dean's UPS system and utilized the LEED grids in a modulated retarding mode as a detector, much as was being done then with combined LEED/Auger systems. In spite of our initial concerns, this setup provided satisfactory spectra.

"We chose tungsten for our initial studies, primarily because its adsorption properties were well characterized. Since a variety of adsorbate structures had been observed on W, it also appeared to provide the best chance for evaluating the sensitivity of UPS to the details of the structure. (It is also relevant that I knew where suitable samples of W(100) and W(110) could be readily obtained.) In retrospect, W was perhaps not the best choice, for this richness of structure also resulted in considerable complexity, which is not desirable in an initial study.

"As was the case with this study, UPS has proved to be extremely useful as a surface study technique, so much so that it is undoubtedly regarded today as one of the indispensable tools of any surface study instrument. The fact that this was one of the first studies to combine UPS with surface analysis probably accounts for the frequent citation of this work. Also, CO adsorption on metal surfaces has received considerable attention in the literature. There was much controversy over whether CO adsorbs in dissociated or molecular form; in this work we were able to identify both forms on the W(100) surface."

1. **Eastman D E & Cashion J K.** Photoemission energy-level measurements of chemisorbed CO and O on NI. *Phys. Rev. Lett.* **27**:1520, 1971.
2. **Eastman D E.** Photoemission energy-level measurements of sorbed gases on titanium. *Solid State Commun.* **10**:933. 1972.
3. **Helms C R & Spicer W E.** Photoemission studies of oxidation of strontium. *Phys. Rev. Lett.* **28**:565, 1972.