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Design and initial performance of a U–V–HREM

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We report here on the basic design and the initial performance of a fully bakeable UHV-HREM. The instrument, see Figure 1,is based upon a conventional H-9000 electron microscope with the natural differential pumping of the column separating the standard gun and photographic chambers from the UHV specimen chamber. The addition of small ion pumps at the condenser aperture, the selected area aperture and between the two projector lenses (see Figure 2) (which attain operational pressures of $\sim 2 \times 10^{-8}$, $\sim 2 \times 10^{-8}$ and $\sim 2 \times 10^{-7}$ Torr respectively) assist this differential pumping. To achieve full UHV performance the specimen region is bakeable to 200℃ using a combination of tape and band heaters and quartz-halogen lamps. Specimens for HREM analysis can be pretreated in the transfer chamber which is shown in Figure 3. The specimens, held in a detachable side entry cartridge, can be moved both back and forward and rotated by 360° to face ports onto which equipment for LEED, ion beam, X-ray, evaporation and dye laser treatment of surfaces will be mounted; the transfer chamber acts as a conventional multi-port surface science chamber.

After treatment, the specimens can be detached from the transfer rod and left vibration isolated in the microscope. Preliminary results, see Figure 4, indicate that the microscope meets and probably exceeds its target resolution of 0.2 nm. In another, not so pretty particle, linear 0.14 nm fringes were observed indicating a resolution on the par with that of the UHR H-9000. Initial tests have confirmed a stable vacuum of 4×10^{-10} Torr at the specimen. For standard 300keV operation the experimentally measured aberrations of the objective lens are Cs=1.3mm and Cc=1mm.

Crucial to the achievement of UHV was the construction of the lens region using completely UHV compatible materials with all metal gasket seals and mirror finish, the avoidance of virtual leaks and designing for high pumping conductance. For instance, the specimen region is pumped with a conductance of about 80 l/sec from the actual specimen position by a tandem turbomolecular pump.

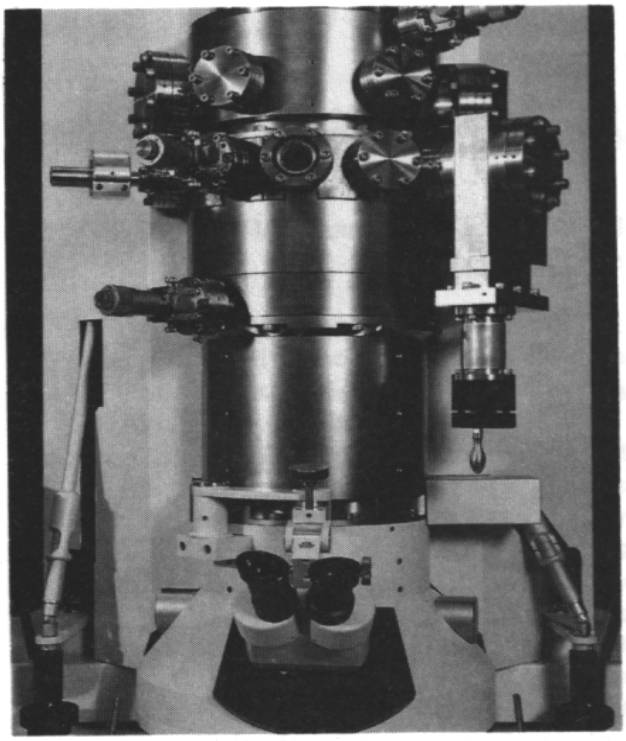

Figure 1. Photograph of the UHV-H9000 without the specimen transfer chamber.

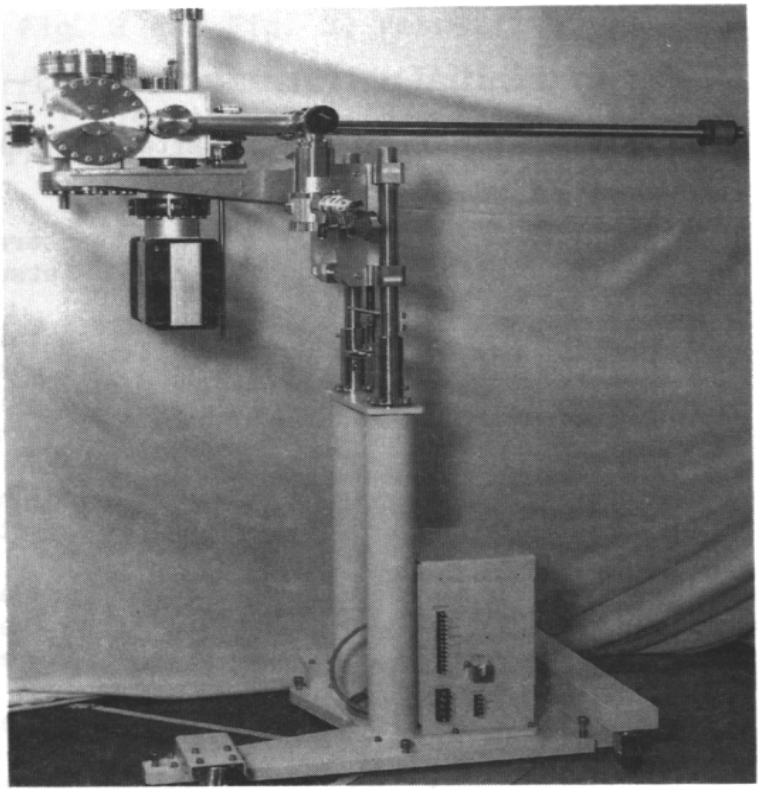

Figure 3. Photograph of the transfer chamber.

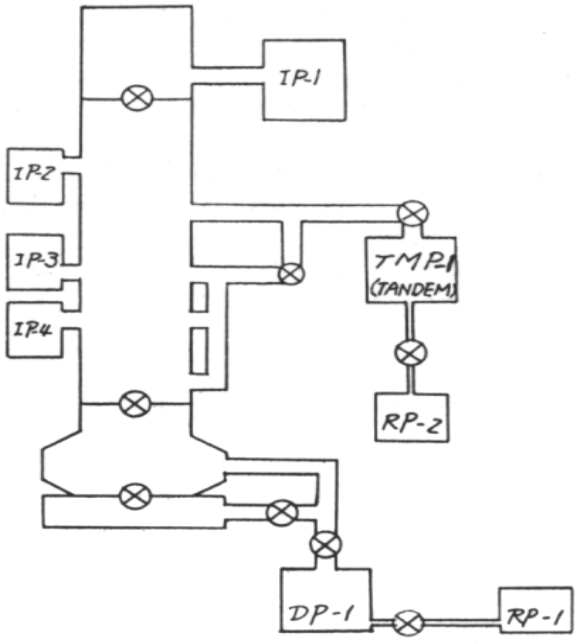

Figure 2. Illustration of the pumping system of the UHV-H9000 showing the four ion pump IP-1~4, the tandem turbo-molecular pump TMP-1, the camera chamber diffusion pumps DP-1 and the two rotary pumps RP-1 and RP-2.

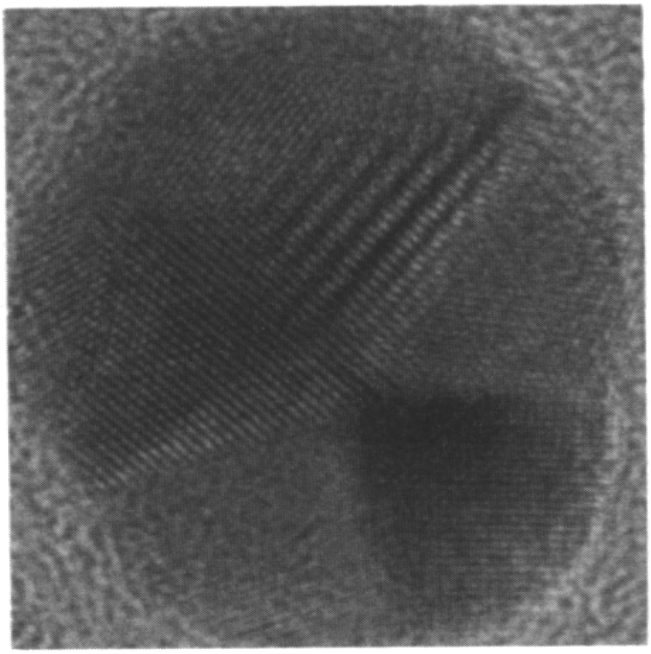

Figure 4. Micrograph of a gold particle showing clearly resolved (111) and (200) fringes of spacing 0.24 and 0.2 nm respectively taken with an exposure time of 4 seconds at an initial magnification of 1 million.