Point Projector Electron Microscope

Electron images of high magnification and resolution can be obtained by making use of the quasi-rectilinear propagation of the field emission from a minute cathode close to the object being examined. The cathode here takes the form of an etched tungsten or molybdenum point similar to those used by Eyring, Makeown and Millikan[1] for cold emission measurements and by E. W. Muller[2] for the study of the variation of work function with crystalline orientation as well as of adsorption phenomena.

The "point projector microscope" thus constituted is essentially a transmission microscope. Consequently the specimens must be prepared so as to be transparent, wholly or partly, to electrons of the velocity corresponding to the applied voltage. Suitable methods of preparation for this purpose have been indicated by L. Marton[3] and H. Ruska.[4]

The magnification of the device depends on the ratio of the distance from the cathode to the viewing screen (or photographic plate) to the distance from the cathode to the object. The latter can readily be varied externally, permitting a wide range of magnifications.

As this type of microscope involves no electron-optical lens elements, the images obtained are free from the ordinary aberrations. The limit of resolution depends solely on the distribution of initial velocities of the field electrons and on Fresnel diffraction by the object, making it possible to proceed beyond the resolution of the light microscope by some orders of magnitude.

Figure 1, (a), (b) and (c), shows images of a 400-mesh electroplated copper screen (0.0008 inch thick) magnified electron-optically 200, 600 and 3000 times, respectively, obtained with a sealed-off point projector microscope. While sharp images of the edge of a hole were observed on the luminescent screen with magnifications up to 8000 times, the mechanical steadiness of the image was here inadequate to permit photography with the increased exposures required at the relatively low lens aperture (f: 4.5) available.

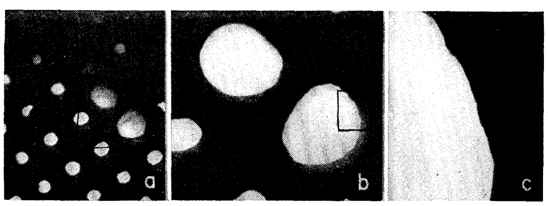

FIG. 1. Electronic projections of 400-mesh copper screen. The area of (c) is marked on (b) and that of (b) is marked on (a).

A more detailed description of the device and its operation will be published elsewhere.

G. A. MORTON
E. G. RAMBERG

Electronic Research Laboratory,
RCA Manufacturing Company,
Camden, New Jersey,
September 11, 1939.

[1] C. F. Eyring, S. S. Makeown and R. A. Millikan, Phys. Rev. **31**, 900 (1928).
[2] E. W. Muller, Zeits. f. Physik **106**, 541 (1937).
[3] L. Marton, Bull. Acad. Belg. Cl. d. Sc. **22**, 1336–1344 (1936).
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Search for Weak Lines in the Molybdenum L Spectrum

Cecil J. Burbank[1] has recently reported the observation of nondiagram lines in the L group of 47 Ag resulting from electron bombardment sufficiently energetic to produce K ionization. The theory of such emission, treated by R. D. Richtmyer[2] is in harmony with Burbank's observations.

An unsuccessful search for similar lines in the spectrum of 42 Mo has just been conducted, with the Burbank apparatus with certain improvements. Since Burbank was greatly troubled by high order reflections of short wave radiation, tending to swamp the weak satellites, we thought it necessary to suppress such radiation and completely succeeded in doing so by interposing a total reflector of magnesium on glass between the silver target and the spectrometer crystal. It was possible to adjust the angle of incidence so that the wave-length region investigated was reflected to the gypsum crystal of the spectrograph almost completely while all radiations capable of higher order reflection were entirely cut off. This technique made possible the use of heavy targets instead of thin layers as used by Burbank.

All of the lines listed by Siegbahn[3] in the region investigated (from $L\gamma_1$ to $L\alpha_2$) were observed and in addition a line, thought to be new, having the wave-length 4979 x.u. was found between β_2 and β_3. Since this line does not disappear when the tube is operated at a potential below the K-excitation voltage it is not a satellite of the type studied by Burbank. The region between β_4 and α_1 was investigated very carefully since the analogy of silver indicated that the strongest satellites of the type sought should appear there. Although exposure conditions appeared at least as favorable as in Burbank's cases none of the expected lines was recorded.

The Auger transitions which result in the double ionization prerequisite to the emission of these satellites are more probable in elements of low atomic number and we had therefore expected the lines to be more intense in the molybdenum than in the silver spectrum. The results indicate that such is not the case.

WERNER VEITH
PAUL KIRKPATRICK

Stanford University,
California,
September 11, 1939.

[1] C. J. Burbank, Phys. Rev. **56**, 142 (1939).
[2] R. D. Richtmyer, Phys. Rev. **56**, 146 (1939).
[3] M. Siegbahn, *Spektroskopie der Röntgenstrahlen.*

Disintegration of N^{14} and N^{15} Produced by Deuteron Bombardment

A mixture of 80 percent N^{14} and 20 percent N^{15} gas has been bombarded with 1.07-Mev deuterons from the Cornell cyclotron. The ranges of the protons and alpha-particles emitted at 90° were measured by means of a shallow ionization chamber and a pulse amplifier. The nitrogen gas at reduced pressure was contained in a target cell of about 1.5 cm^2 volume. This cell was separated from the cyclotron chamber by a thin aluminum foil. On the side of the cell another aluminum window allows particles emitted in a direction at 90° to the deuteron beam to enter

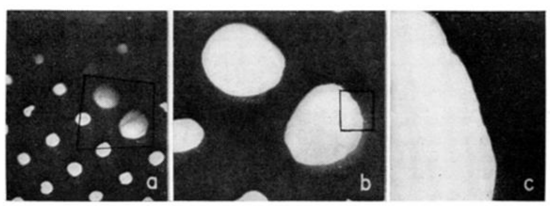

FIG. 1. Electronic projections of 400-mesh copper screen. The area of (c) is marked on (b) and that of (b) is marked on (a).