soluble in solutions of alkali hypochlorites. When an excess of alkali is present, ruthenates are formed; when no excess of alkali is present, some ruthenium tetroxide is formed.

2. When finely divided, ruthenium can be completely separated from the other platinum metals, except osmium, by solution in hypochlorites.

3. From a solution of potassium ruthenate, ruthenium can be completely distilled as tetroxide, after treatment with chlorine.

4. No satisfactory way has been found to precipitate quantitatively in weighable form the ruthenium from the tetroxide.

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NOTE

An Attempt to Excite a Mercury Surface by Electron Bombardment.—The present results on chemical effects incident to the electron bombardment of a mercury surface are tentative in the sense that they lead to no clear-cut interpretation, but since it is impossible to continue the work in the immediate future it is deemed best to publish the observations made.

The method adopted to detect excitation of the surface was very simple in principle. Potentials of 0–240 volts were impressed between a hot-wire filament and a mercury surface in an apparatus similar to that used by Moore and Noyes[1] in their investigation of the relation of photoelectric effect to photochemical action on mercury. This reaction vessel was evacuated to pressures of 10^{-4} to 10^{-5} mm. and oxygen gas admitted a fraction of a second before the filament current was turned off in the hope that the presence of excited mercury atoms could be detected by formation of oxide. Filaments (tungsten, thoriated tungsten, platinum and oxide-coated platinum were tried in separate experiments) were mounted 5–7 cm. from the surface of area approximately equal to 0.75 sq. cm. This distance is considerably less than the mean free path of electrons at the pressures used.

A distinct indentation, or crinkling, of the surface was always found to occur when oxygen at pressures ranging from 7–30 cm. was admitted suddenly before the filament current was switched off. Moreover, this effect was found to persist when the gas was admitted at times as long as five minutes after turning off the filament current. Evidently this "long-time" effect is scarcely anticipated by the assumption that the duration of excitation of surface atoms of a solid is of the same order as that of a gas. In every case, however, it was noticed that when the excess of oxygen was pumped out after a run this extremely tenuous

[1] Moore and Noyes, THIS JOURNAL, **46**, 1371 (1924).

film seemed to vanish, but when more gas was passed in a similar and often more pronounced, indentation was obtained. When the reaction chamber was evacuated a second time and the surface renewed in a vacuum subsequent admission of the gas failed to produce any perceptible change in the character of the surface. It seems clear that the effect, whatever it may be, is due to local alteration in the surface layer of atoms, since the spilling of one drop of mercury sufficed to renew the surface completely.

Some experiments were made in which the field was reversed, that is, impressed in such a way as to hinder the bombardment of the surface by electrons. Positive results were frequently obtained under these circumstances with the thoriated tungsten and oxide-coated platinum filaments. This phenomenon shows clearly that the "crinkling" test is a composite one, and does not differentiate sharply between activation of the gas in the vacuum tube and excitation of the surface. Indeed, it is impossible to estimate visually whether more oxide is formed with increased intensity of the electron stream, and since the effect is independent of voltage for thoriated tungsten and oxide-coated platinum filaments at least, it is certain that extraneous factors are operative.

In view of the uncertainties involved, it may seem inappropriate at this time to suggest an hypothesis for the action. It is not unlikely, however, that the "long-time" effect is due to the initial formation of a monomolecular layer of mercuric oxide by action of the filament. This invisible layer of oxide conceivably might retain mechanically any electrons received directly from the filament, or indirectly by some other process operative in the tube. When more gas is admitted to the surface, it reacts with these electrons held within the space lattice of this invisible film, and produces the indentations so frequently observed.

It is interesting to note that Foote, Meggers and Chenault[2] have attempted to detect active states in copper, carbon, platinum and iron targets when bombarded by 1000-volt electrons. Wholly negative results were obtained in demonstrating the emission of visible or ultraviolet lines by these anticathodes with the aid of the photographic plate. Nevertheless, these experiments do not preclude the possibility of success with a chemical method as a means of registering active states on a metallic surface. Indeed, the achievement of an accurate technique might lead to a distinct evidence of the excitation of solid metallic surfaces by electron bombardment.

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[2] Foote, Meggers and Chenault, *J. Optical Soc. Am.*, **9**, 541 (1924).