

ВЛИЯНИЕ ИОННОЙ БОМБАРДИРОВКИ НА СКОРОСТЬ ТРАВЛЕНИЯ И СОСТАВ ПОВЕРХНОСТИ ПЛЕНКИ РУТЕНИЯ В КИСЛОРОДСОДЕРЖАЩЕЙ ПЛАЗМЕ

EFFECT OF ION BOMBARDMENT ON ETCHING RATE AND SURFACE COMPOSITION OF RUTHENIUM FILM IN OXYGEN-CONTAINING PLASMA

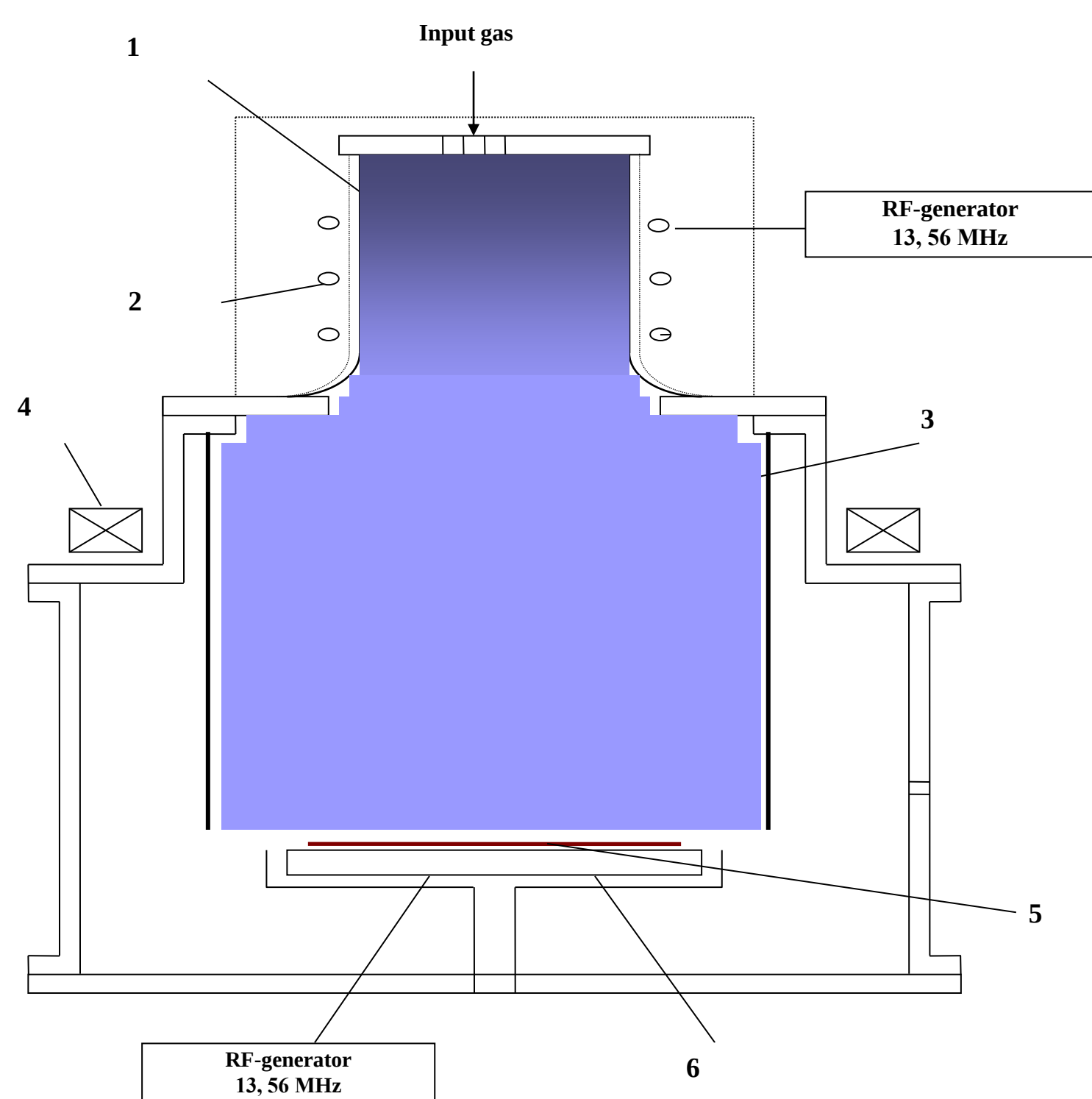
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Ruthenium is one of the promising metals for using its nanoelectronics technology to form metallization tracks of integrated circuits with sub-10 nm element sizes. The formation is carried out using the process of plasma chemical etching in oxygen-containing plasma or in plasma with chlorine additives. In O_2/Ar plasma, Ru etching is caused by the formation of volatile RuO_4 compounds on the metal surface. The rate of Ru etching increases linearly with an increase in the concentration of oxygen atoms, but the effect of ion energy on metal etching has not been studied, although the anisotropy of etching is determined by ion bombardment. This paper presents the results of a study of the etching of a ruthenium film depending on the ion energy in an oxygen plasma with a small addition of Kr.



Schematic of the plasma reactor of RF inductive discharge.

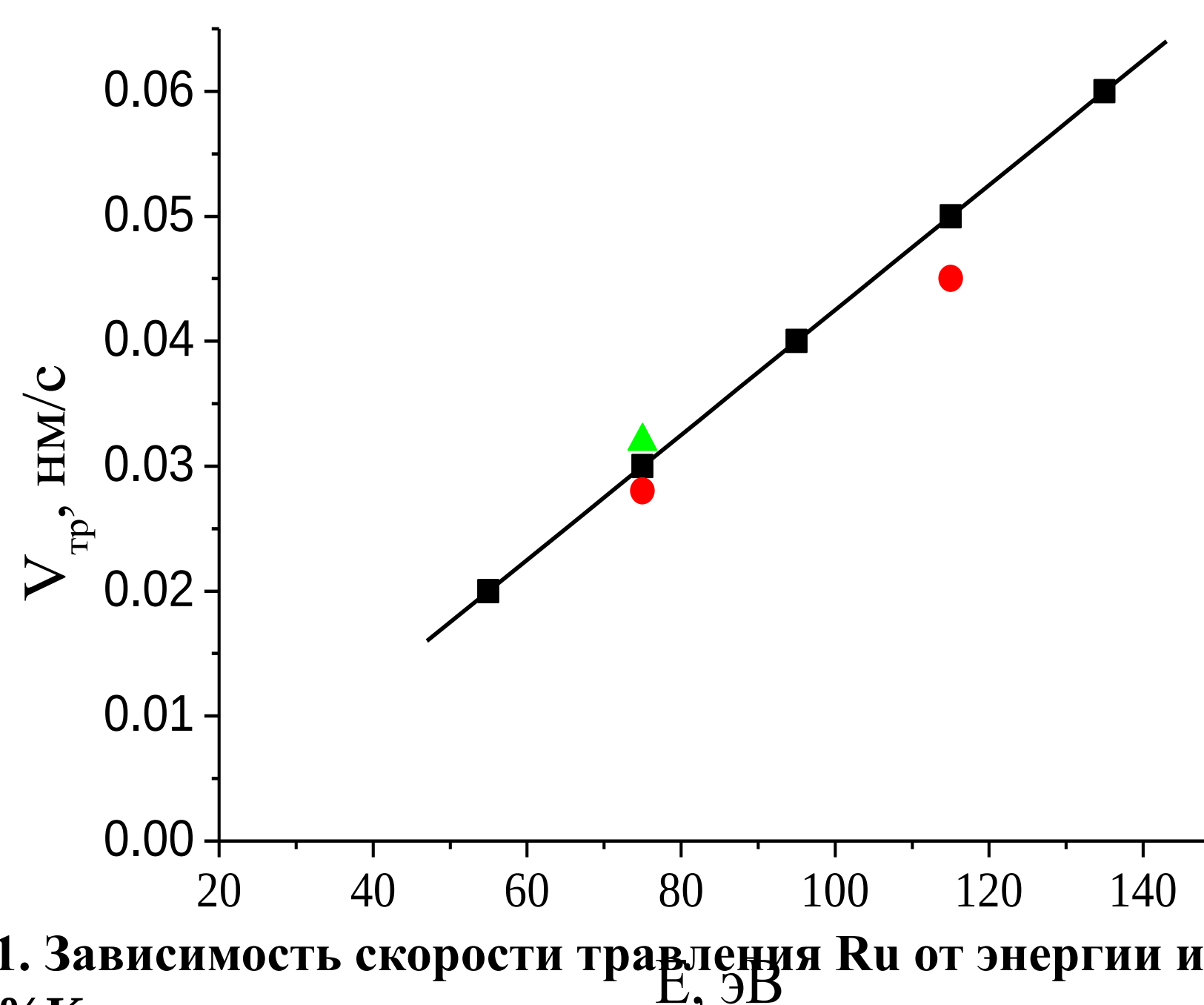


Рис. 1. Зависимость скорости травления Ru от энергии ионов в плазме $O_2+5\%Kr$.

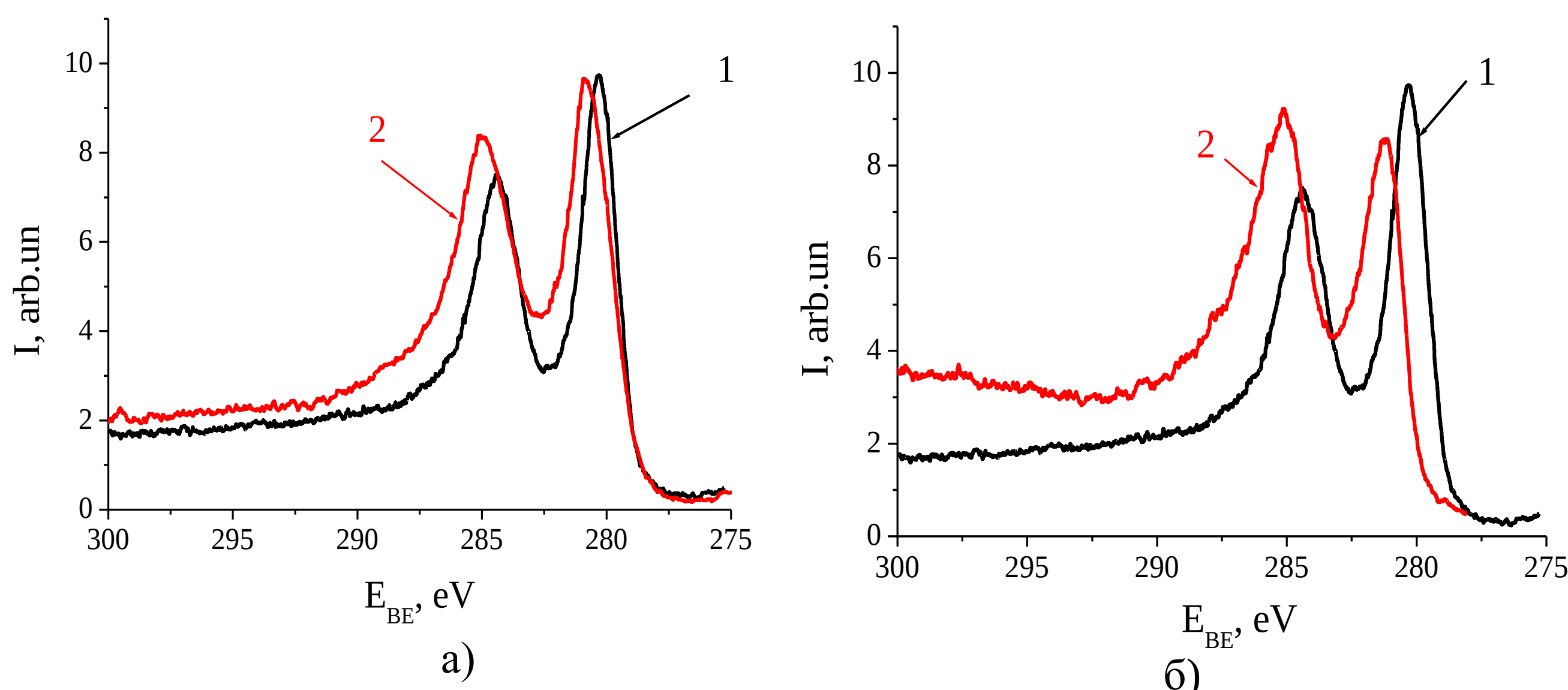
Fig. 1. Dependence of the etching rate of Ru on the energy of ions in plasma $O_2+5\%Kr$.

The conditions of the experiments:

Plasma $O_2+5\%Kr$. $P=0.6$ Pa, 800 W.
RFES spectra - Leybold LHS-10

Рис. 2. РФЭС спектры уровней Ru3d поверхности исходной окисленной поверхности пленки Ru (2) —а) и после воздействия плазмы O_2/Kr при энергии ионов ~ 35 эВ (2) — б). 1 — РФЭС чистой поверхности Ru.

Fig. 2. RFES spectra of Ru3d levels on the surface of the initial film Ru (2) —a) and after exposure to O_2/Kr plasma at an ion energy of ~ 35 eV (2) — b). 1 — RFES of the pure surface Ru.



It is shown that the rate of etching of the ruthenium surface in O_2 plasma with a small addition (5%) of the inert gas Kr increases linearly with an increase in ion energy from 35 to 135 eV. Using X-ray photoelectron spectroscopy, it was found that a reaction thin layer of RuO_2 oxide is formed on the ruthenium surface during etching at low ion energy (~ 35 eV). This indicated that metal etching is limited by ion bombardment.