Amorphous RuO_2 capping layers for EUVL Mirrors

A surface science analysis

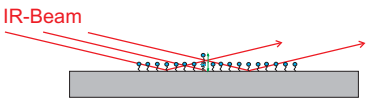
A. Farkas[1], G. Ch. Mellau[1], M. Fang[2], M. Chandhok[2] and H. Over[1]

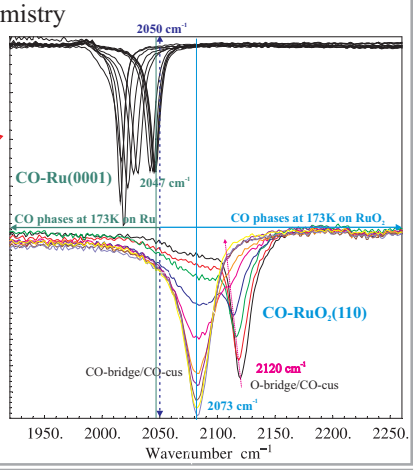
1) Justus-Liebig-Universität Giessen, Physikalisch-Chemisches-Institut, Heinrich-Buff-Ring 58, 35392 Giessen,GERMANY

2) INTEL Corp., 5200, NW Elam Young Pkwy Hillsboro, OR 97124, USA

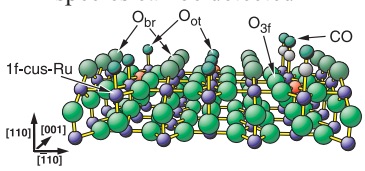
Experimental Ru /RuO_2 characterization

- FT Infrared spectroscopy of adsorbed CO molecules
- CO is probing the surface chemistry
- Sensitive on surface status

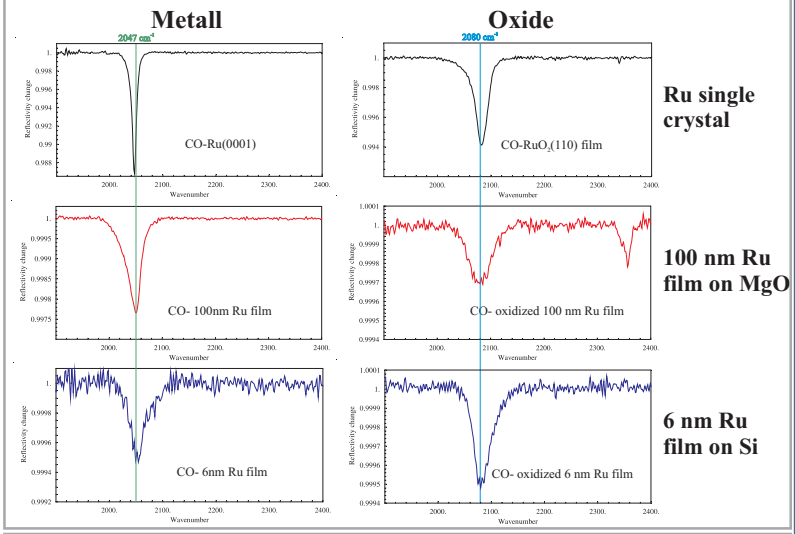




- On RuO_2 the presence of O_{br} species can be detected

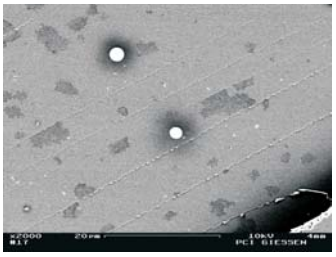


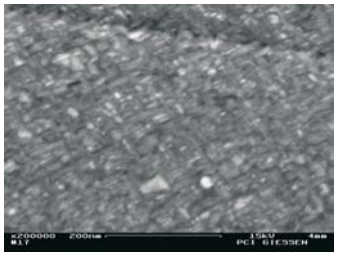
Modell System



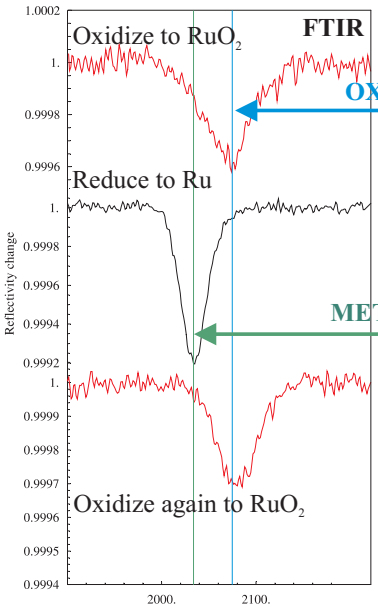
Results for the 100 nm Ru film on MgO

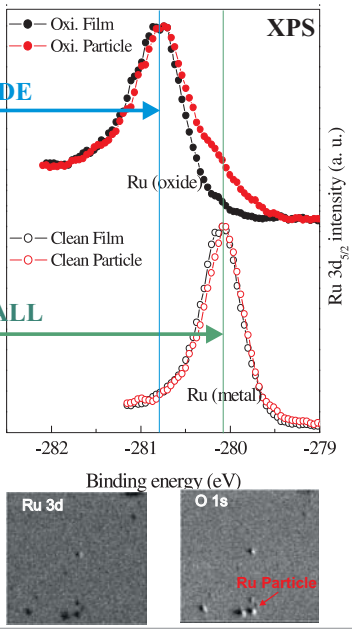
- Ru-film on MgO(100): Ru grain size is 20-40 nm. SEM image :





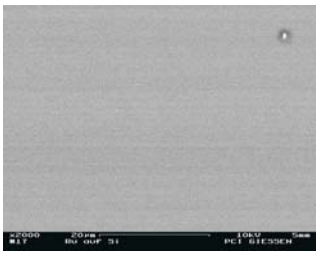
- X-ray diffraction : Ru film is not preferentially oriented along (0001)
- Surface preparation : Ar sputtering + heating up to 200°C.
- Oxidation to RuO_2 and reduction in H_2 to Ru similar to single crystal

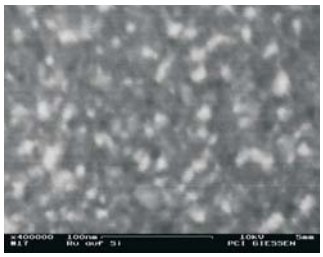




Results for the 6 nm Ru film on Si (produced by LLNL, S. Bajt)

- Ru-film on amorphous Si, grain size 1-2 nm (LLNL). SEM image :





- LLNL: Ru film is preferentially oriented along (0001)
- X-ray reflectivity : thickness 7.2 nm, roughness 0.3 nm
- EDX : the samples have little oxygen contamination
- Surface preparation/activation : Ar sputtering + heating up to 200°C.
- Oxidation to RuO_2 takes place only after Ar sputtering.
- RuO_2 film exposed to 10^{-2} mbar H_2 atmosphere at 200°C is not reduced to Ru - Reduction occurs for the single crystal and also for the 100 nm Ru film !
- Amorphous RuO_2 can only be prepared by direct RuO_2 deposition
- Future work :
  - -Find out why the Ru film surface as prepared is inactive for oxidation and CO adsorption. Only after Ar sputtering CO can adsorb and the Ru film can be oxidized in O_2 atmosphere.
  - -Experiments to find out why the 6nm film cannot be reduced in H_2
  - -Experiments to compare the catalytic chemistry of the 6 nm film surface to that of the 100 nm Ru film, Ru (001) and RuO_2 powder
- Acknowledgements :
  S.Bajt for the 6 nm Ru film preparation
  C. Korte for the 100 nm film preparation, SEM, EDX measuremenets
  Y. B. He for XPS, X-ray reflectivity measurements
  A. Goryachko for XPS measurements