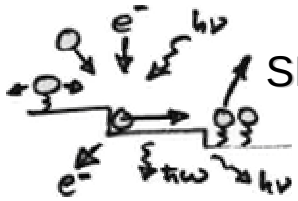

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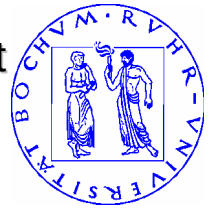


Photo-induced charge transport in metal–insulator–metal (MIM) multilayer structures

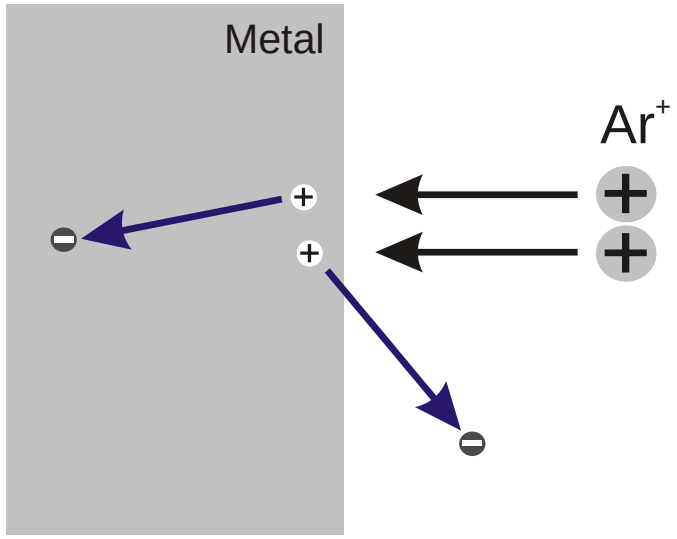
D. Kovacs, J. Winter, D. Diesing

DPG Frühjahrstagung

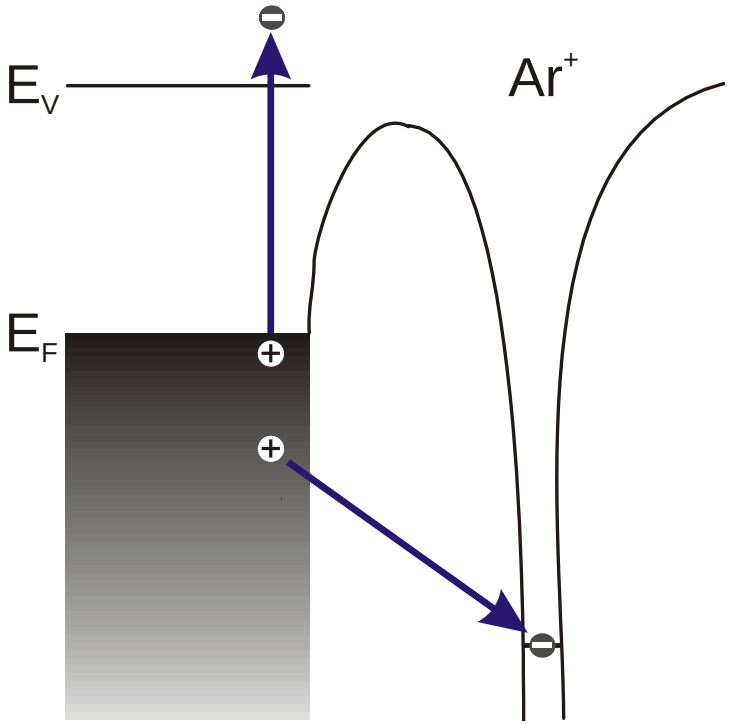
Regensburg, 26-30 März 2007

Motivation

Particle induced electronic excitations at metal surfaces

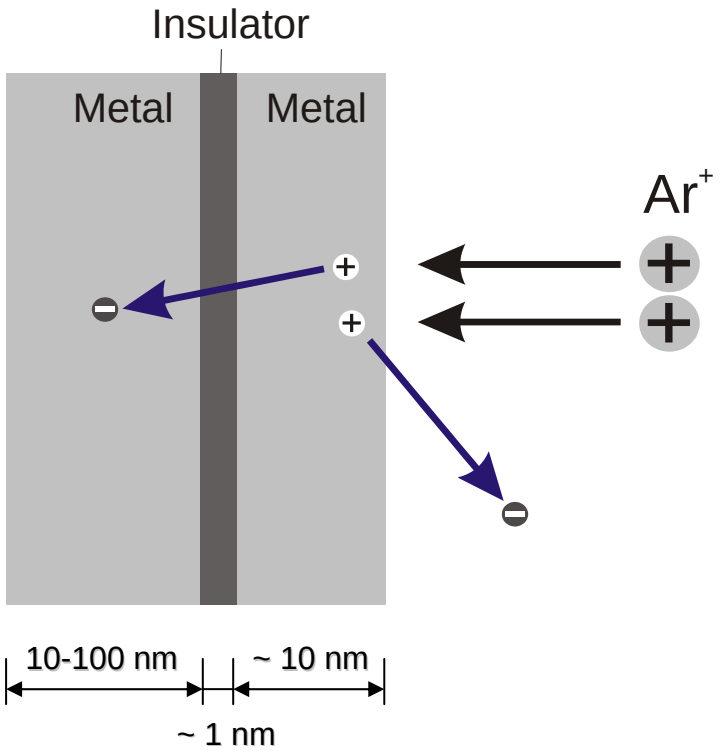


Ion neutralization spectroscopy

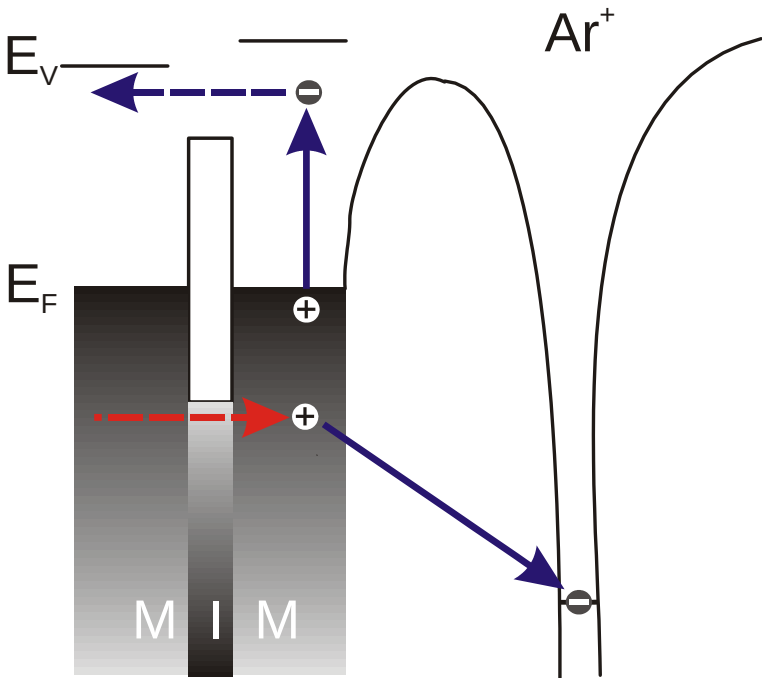


Motivation

Particle induced electronic excitations in MIM structures

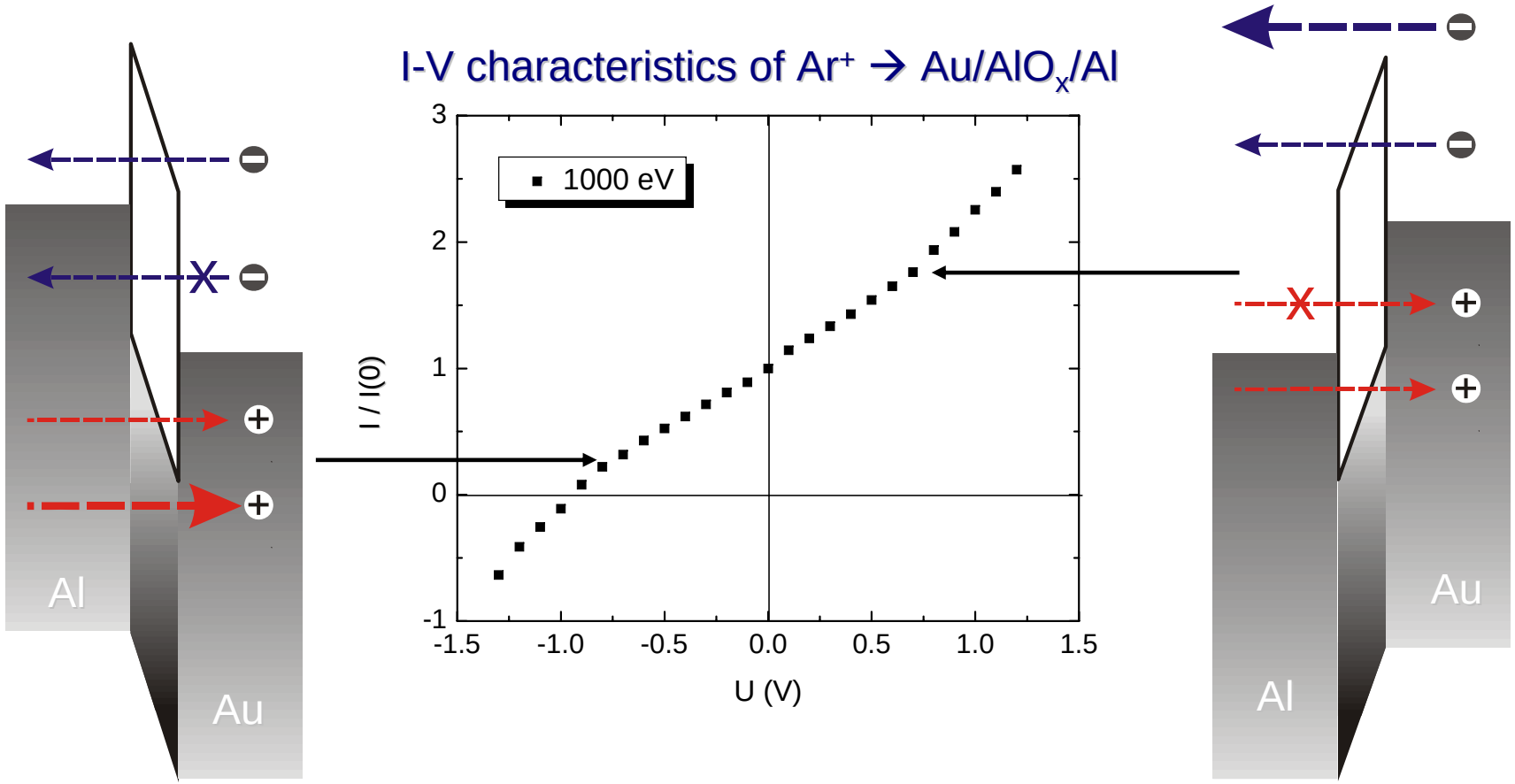


Ion induced tunnel current



Motivation

Ion induced internal emission



Motivation

Observation:

- Hole-induced polarity change in particle induced tunnel currents !

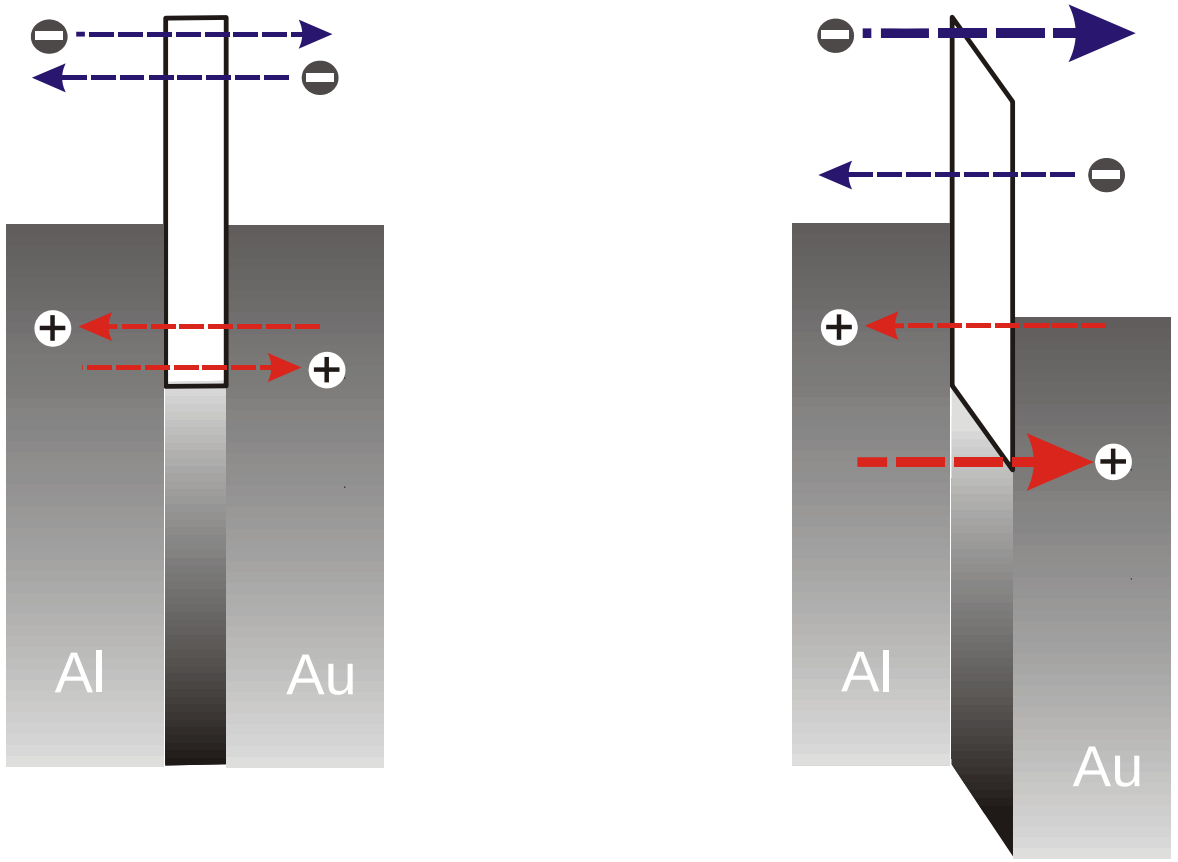
In this talk:

- Comparison with photo-induced tunnel currents
- Comparison with existing theory* on internal photoemission in MIM structures

* J. Kadlec, Phys. Rep. 26, No.2 (1976) 69-98

Theory

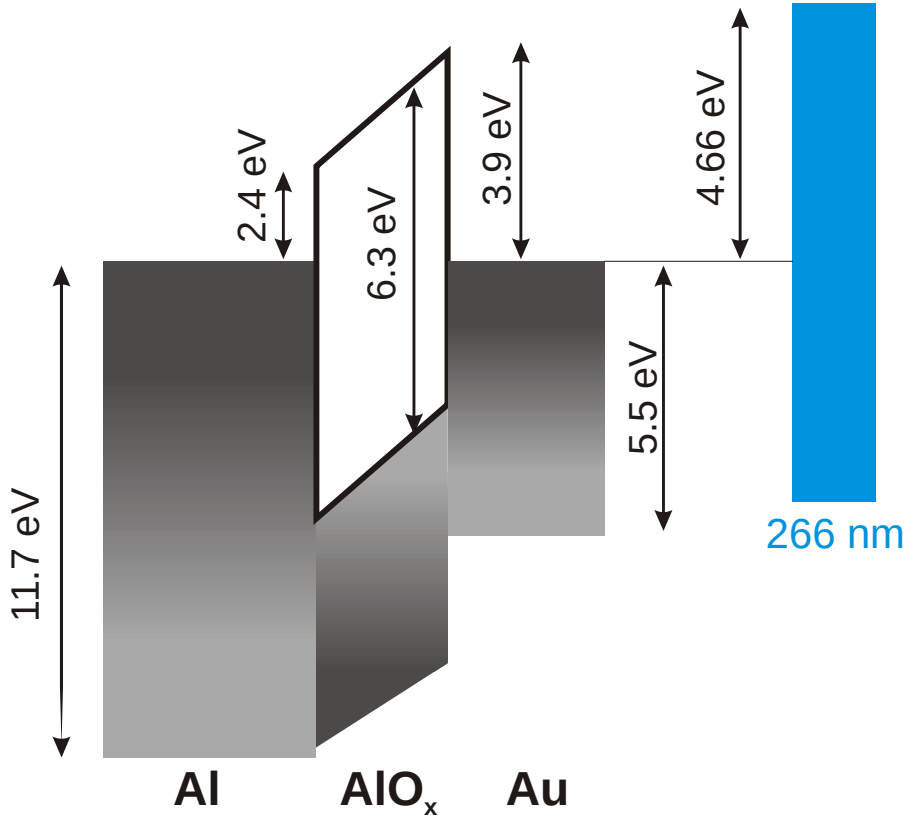
Excitation of electron-hole pairs in the back electrode



Theory

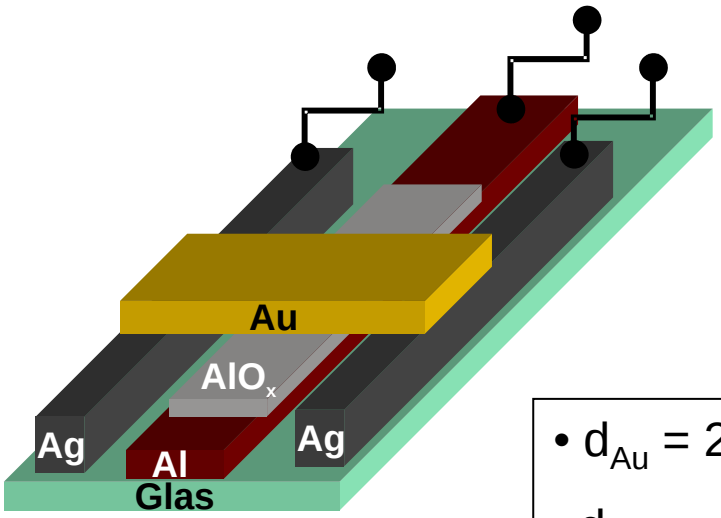
Assumptions

- photoabsorption:
  - → Fresnel optics
- electron-hole pair excitation:
  - → Fermi electron gas
- transport through metal:
  - → ballistic transport
  - → inelastic scattering
- transport through oxide:
  - → WKB approximation
  - → no scattering



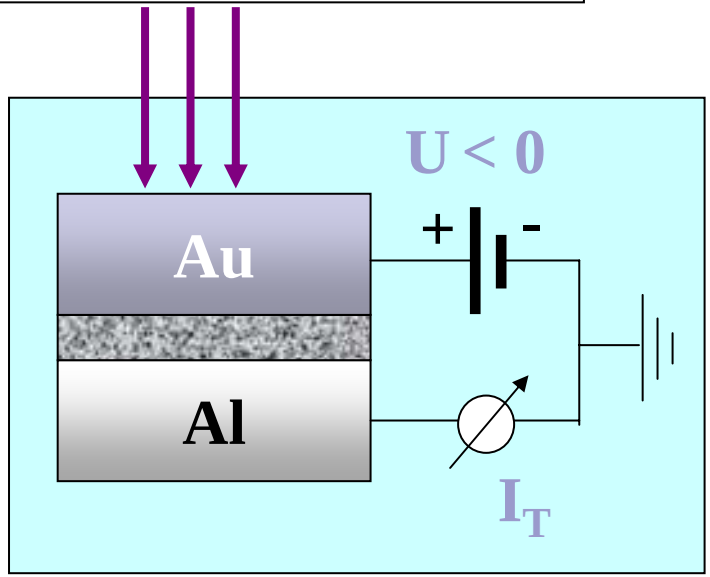
Experimental setup

Metal-Insulator-Metal structure



- d_{Au} = 20..40 nm
- d_{AlOx} = 4 nm
- d_{Al} = 50 nm

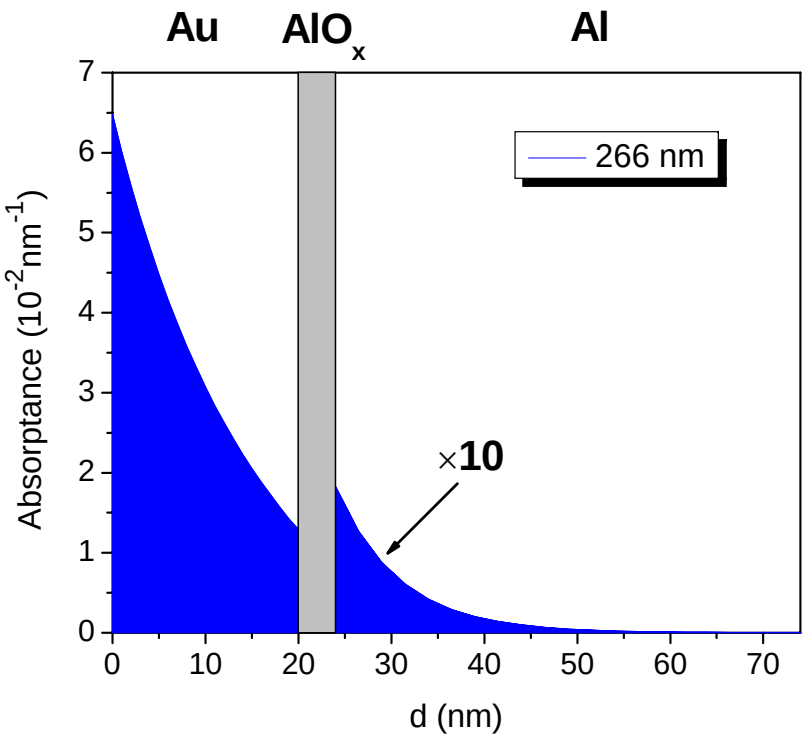
- Source: Nd-YAG laser
- Wavelength: λ = 266 nm
- Angle of incedence : 0°



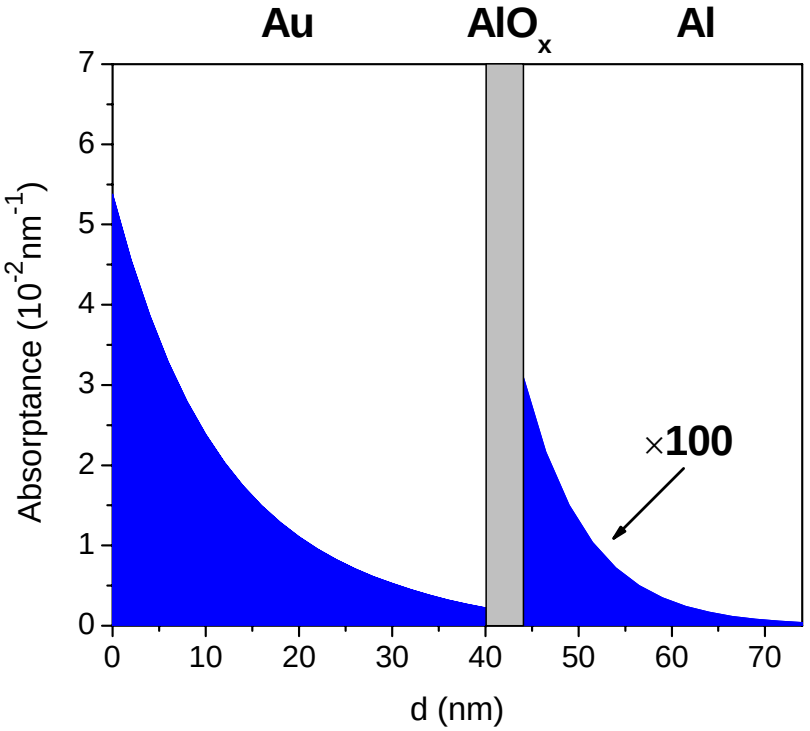
Theory

Photoabsorption in $Au/AlO_x/Al$ at 266 nm

d_{Au} = 20 nm



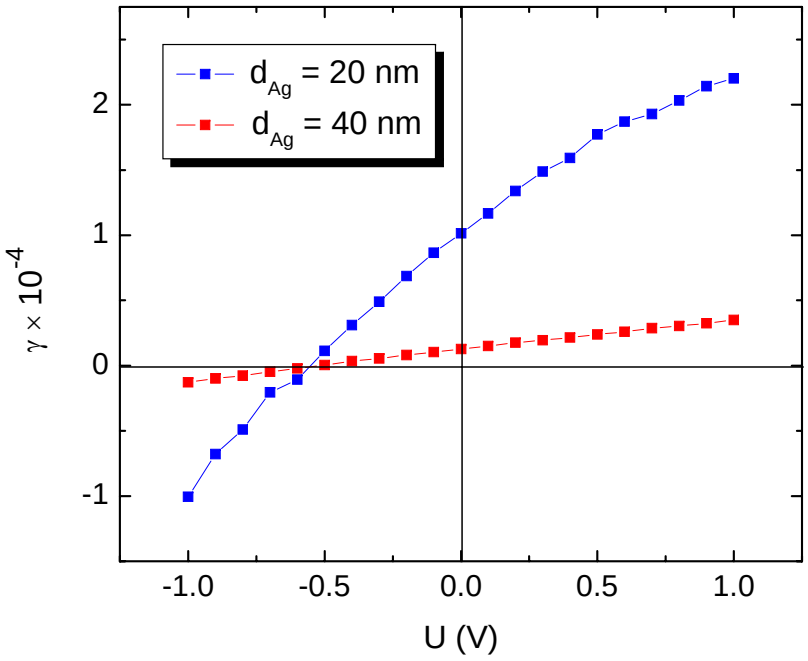
d_{Au} = 40 nm



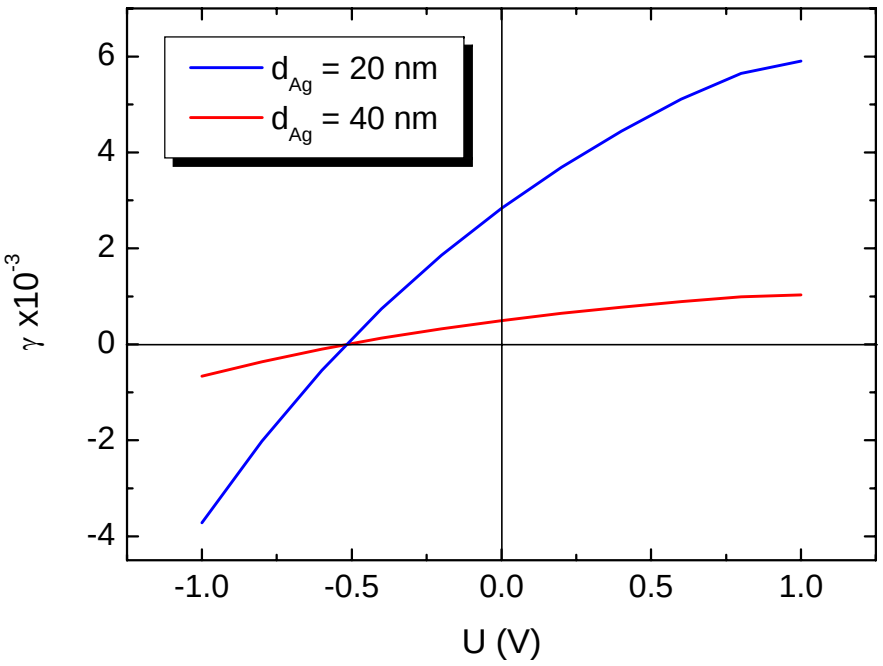
Results

Photoconduction in $Au/AlO_x/Al$ at 266 nm

Experiment



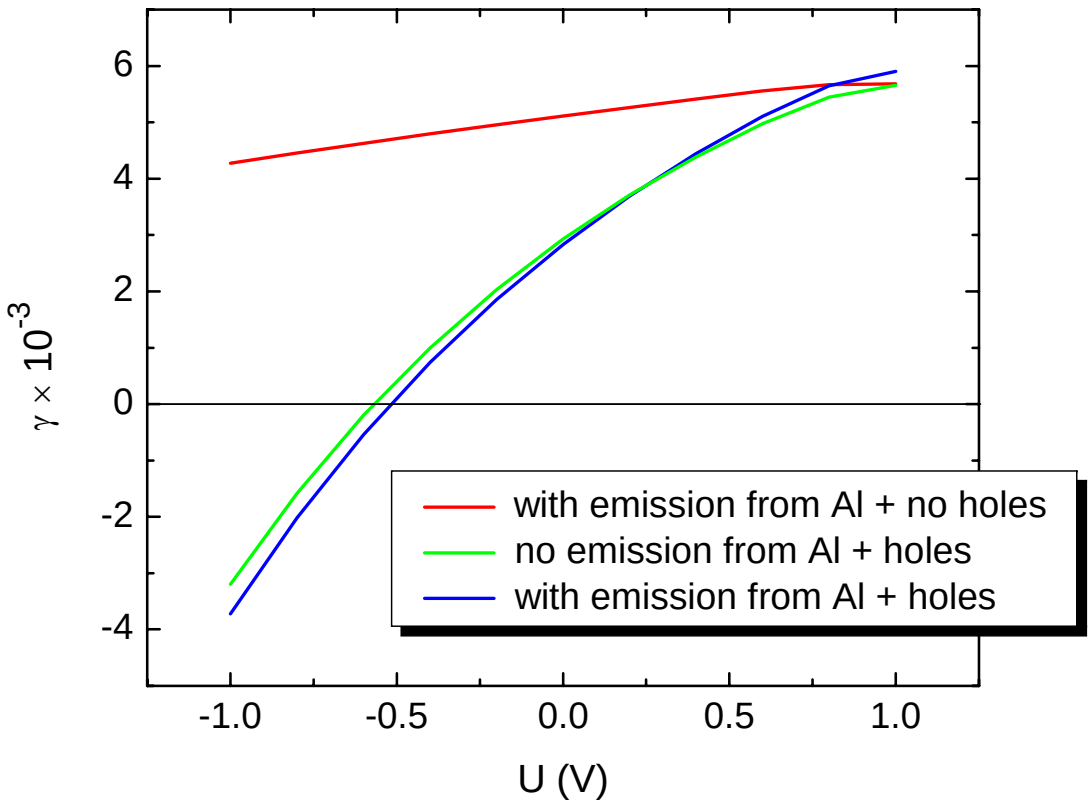
Theory



γ : net number of electrons flowing through the oxide barrier per incident photon

Results

Influence of Al→Au emission



Summary

- hole induced polarity change of the photo-induced tunnel current in metal-insulator-metal structures
- cross over point (for polarity change) independent on illuminated layer thickness - in agreement with theoretical predictions
- minor influence of the back electrode

Acknowledgements

- Kristian Laß and Eckart Hasselbrink for technical support
- DFG for financial support in the framework of the SFB 616