Observation of New Quantum Interference Effect in Solids

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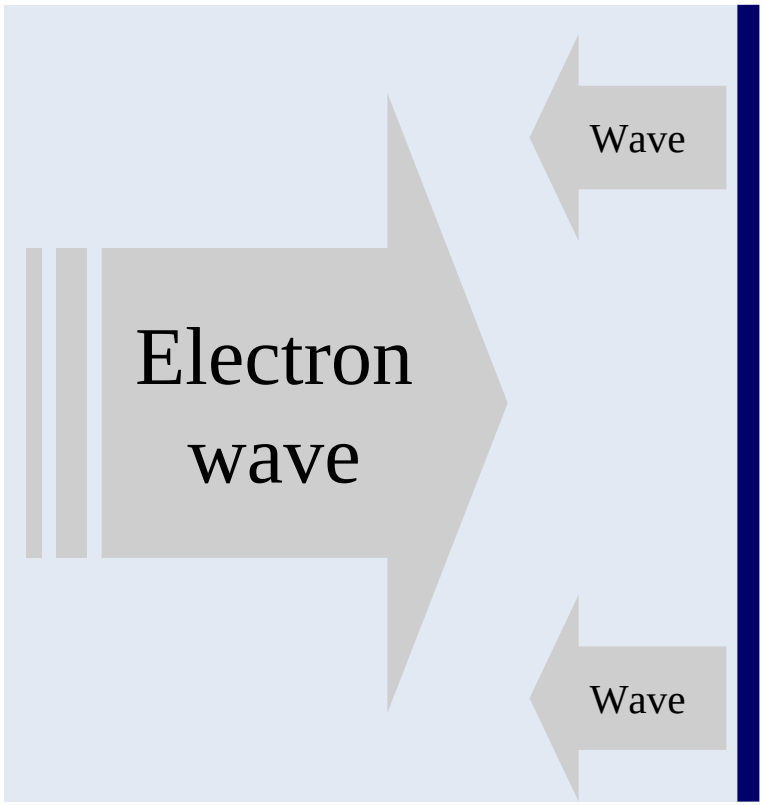
Introduction

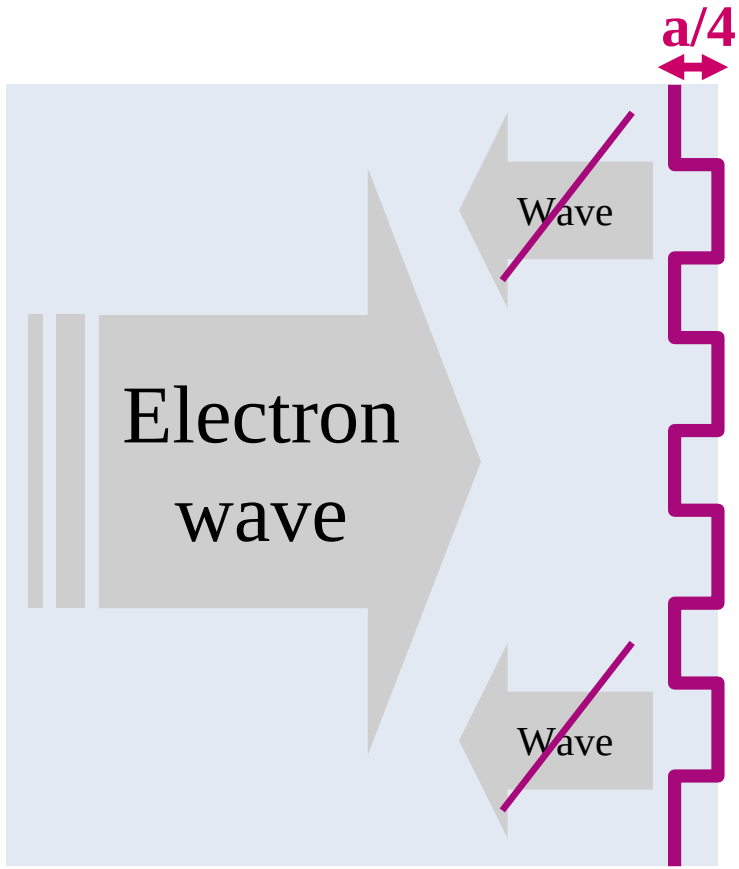
- Nanostructures dimensions are approaching the wavelengths of the electrons in the solid.
- Super lattices and resonant tunneling structures use these wave properties.
- Smaller dimensions, enable new methods for reducing the electron volt work function of a surface.

Basic Principles

Simplified model



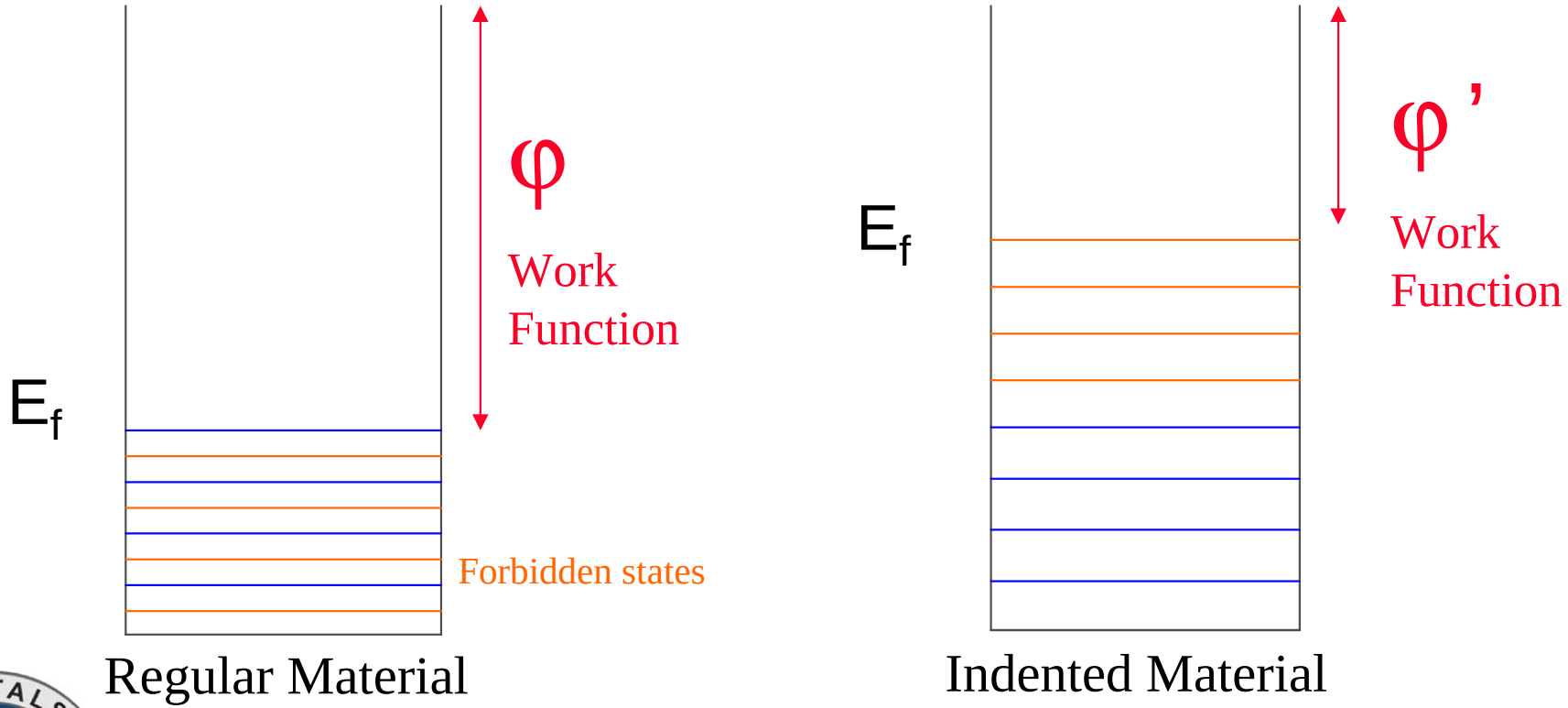
Regular Material



Indented Material

Basic Principles (2)

If the final states are forbidden then the initial state is also forbidden.

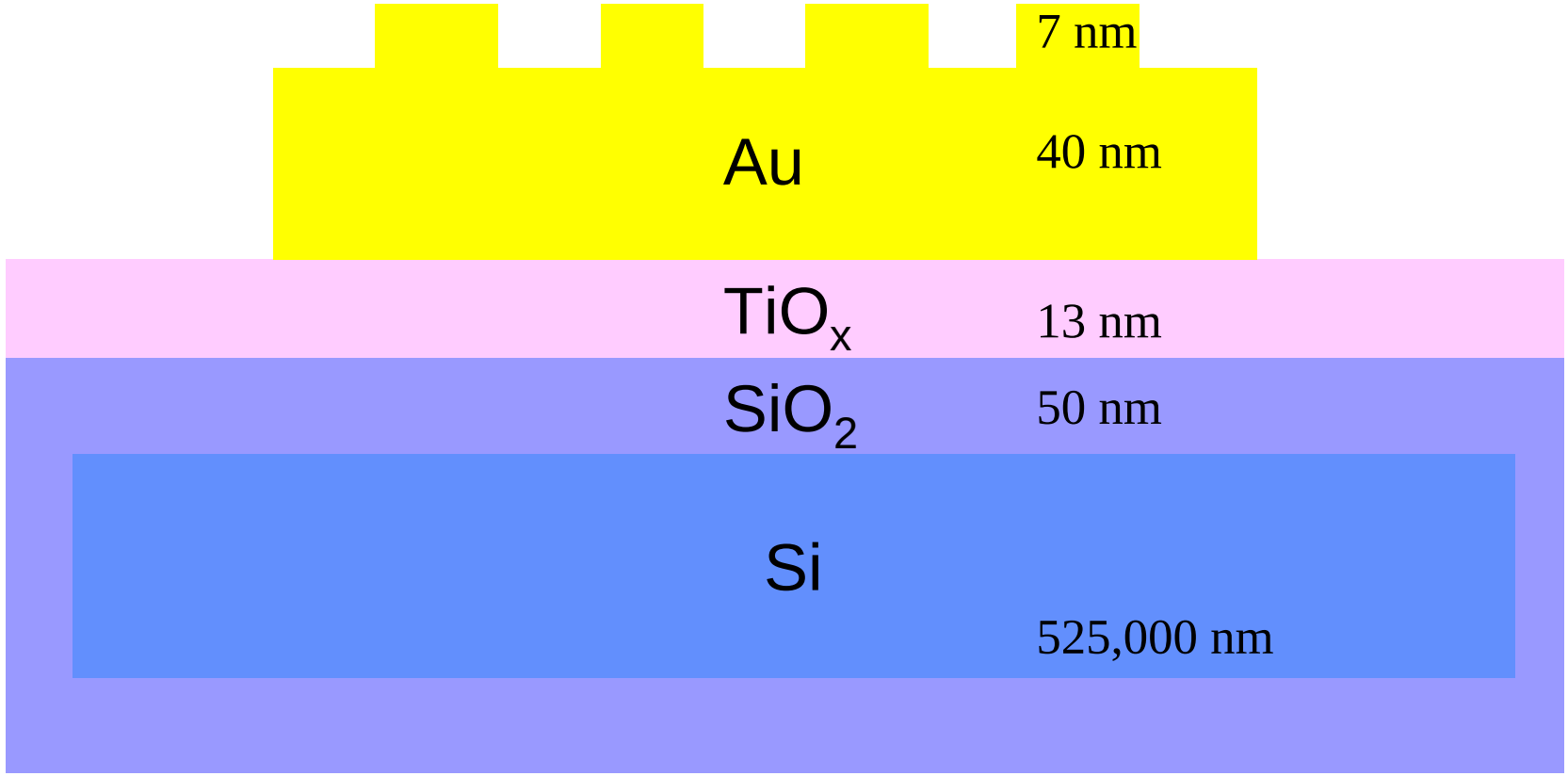


Limiting Factors

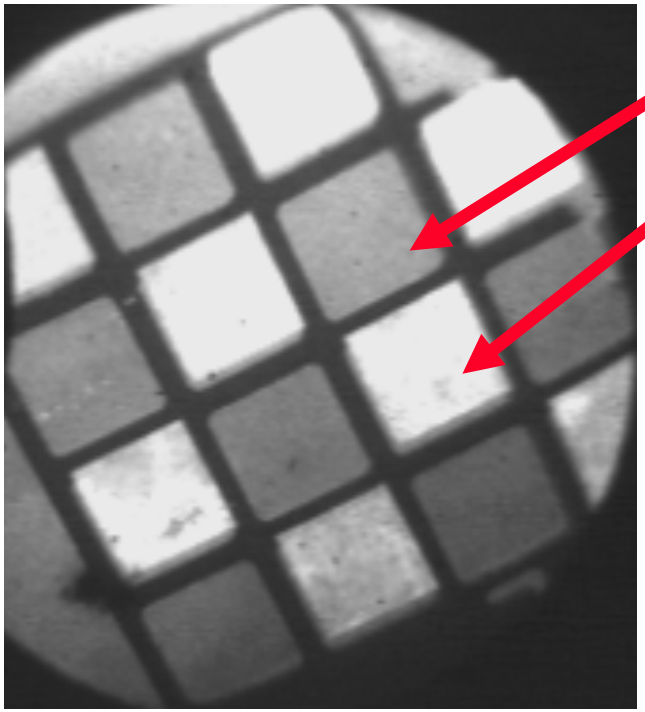
Limiting factors in practice

- The surface roughness should be less than the electron's de Broglie wavelength.
- To avoid scattering at grain boundaries, single crystals are preferred, though amorphous solids are acceptable.
- Different geometries for measurement PEM/KP.

Current Test Samples

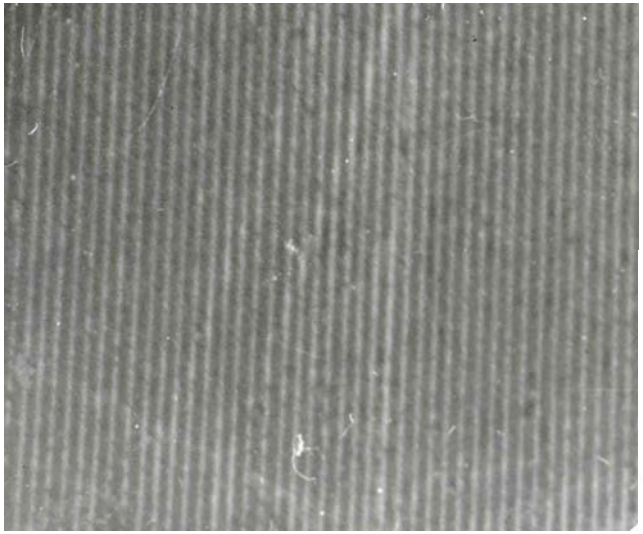


Sample Measurement - PEM



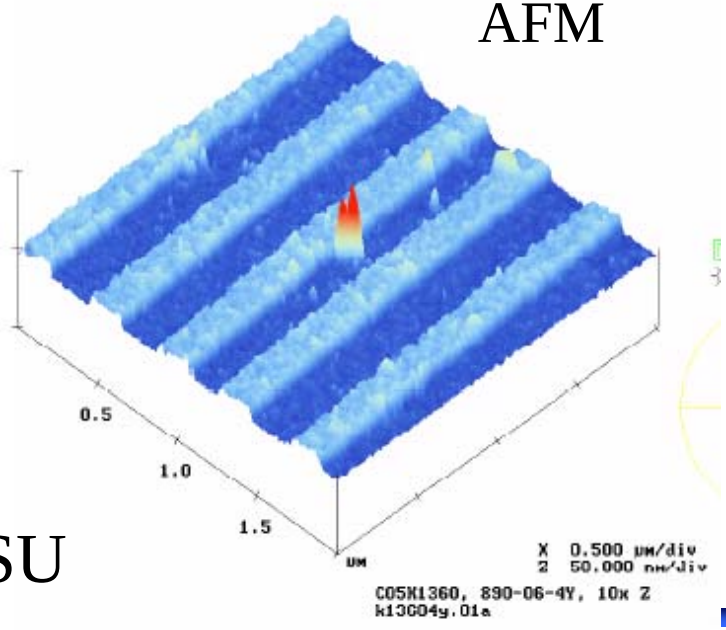
Regular material

Indented material



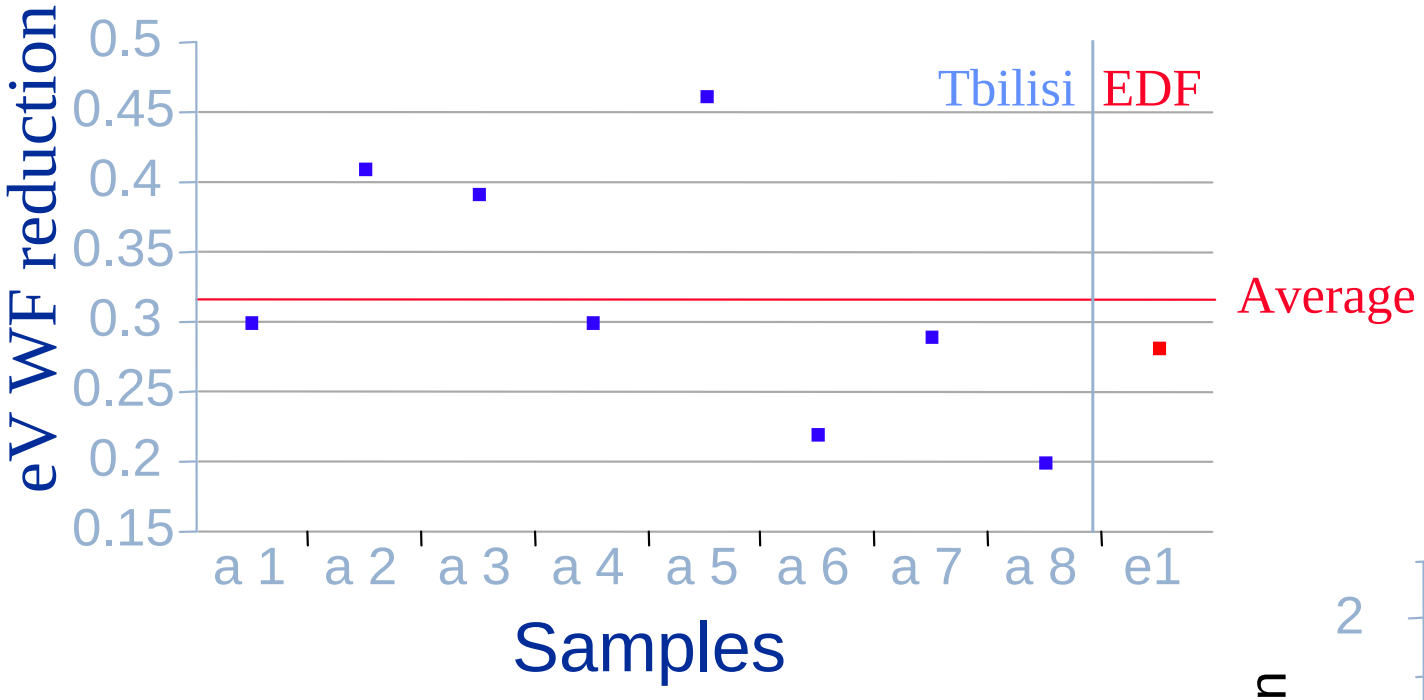
High Resolution of indents

AFM



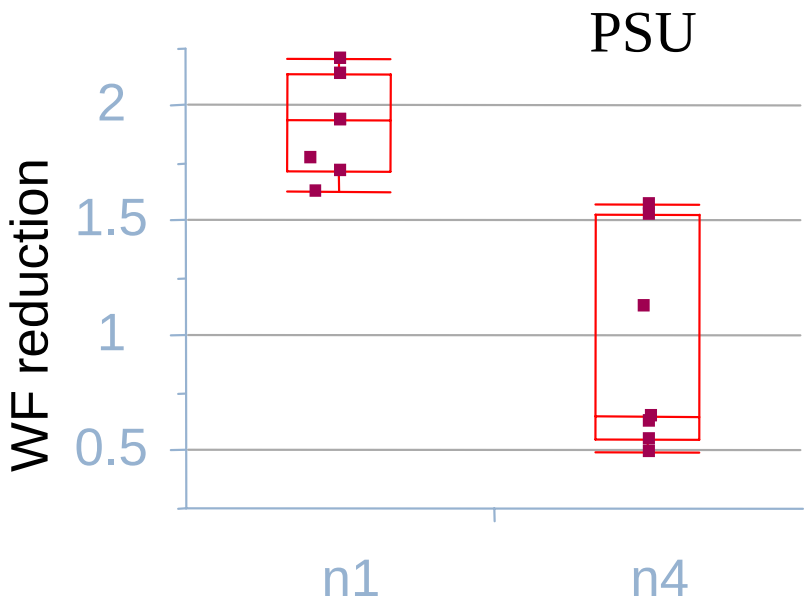
Newest Generation of Samples -- PSU

Kelvin Probe Results- Au



Greater than 0.3 eV WF reduction

- multiple samples
- 3 labs
- older generation of samples



Conclusions and Next steps

- Samples show lower work function for indented surfaces as measured with Kelvin Probe. Effect is seen in PEM results.
- More samples and measurements are underway for
  - Reducing dimensions of indents using E-beam lithography.
  - Ability to measure PEM and Kelvin Probe on same sample.
  - Evaluating effect on other materials.