SPECULATIONS ON LISA GRS WORK FUNCTION STABILITY ON ORBIT

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Workshop on Charging
MIT- Cambridge, MA
July 26-27, 2007
G070578-00-R

Mechanisms for Changing Work Function

- Diffusion of chemisorbed atoms (activation energies >> kT) over surfaces
- Redistribution of physisorbed atoms (lower activation energies) in response to changed temperature distributions
- Contamination due to virtual leaks, etc.

Some References on Motion of Atoms on Surfaces

- D A. King, “Surface diffusion of adsorbed species: A review,” J. Vac. Sci. Technol. **17**(1), 241 (1980).
- G. Ehrlich, “Quantitative examination of individual atomic events on solids,” J. Vac. Sci. Technol. **17**(1), 9 (1980).
- G. Ayrault and G. Ehrlich, “Surface self-diffusion on an fcc crystal: An atomic view,” J. Chem. Phys. **60**(1), 281 (1974).
- J. M. Obrecht, R. J. Wild and E. A. Cornell, “Measuring electric fields from surface contaminants with neutral atoms,” Phys. Rev. A **75**, 062903 (2007).

#3

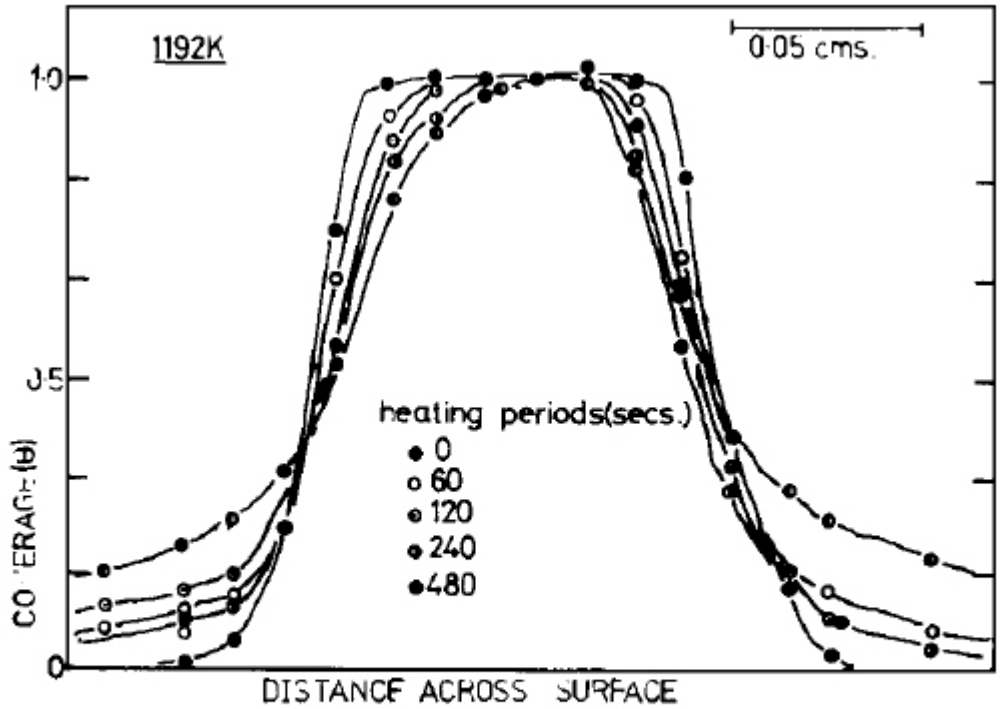

FIG. 3. Diffusion boundary profiles obtained by Bowker and King[18] for an oxygen patch adsorbed on W{411} after periods of heating at 1192 K. For this system E_m = 220 kJ mol^{-1}, D_o = 0.003 cm^2 s^{-1}.

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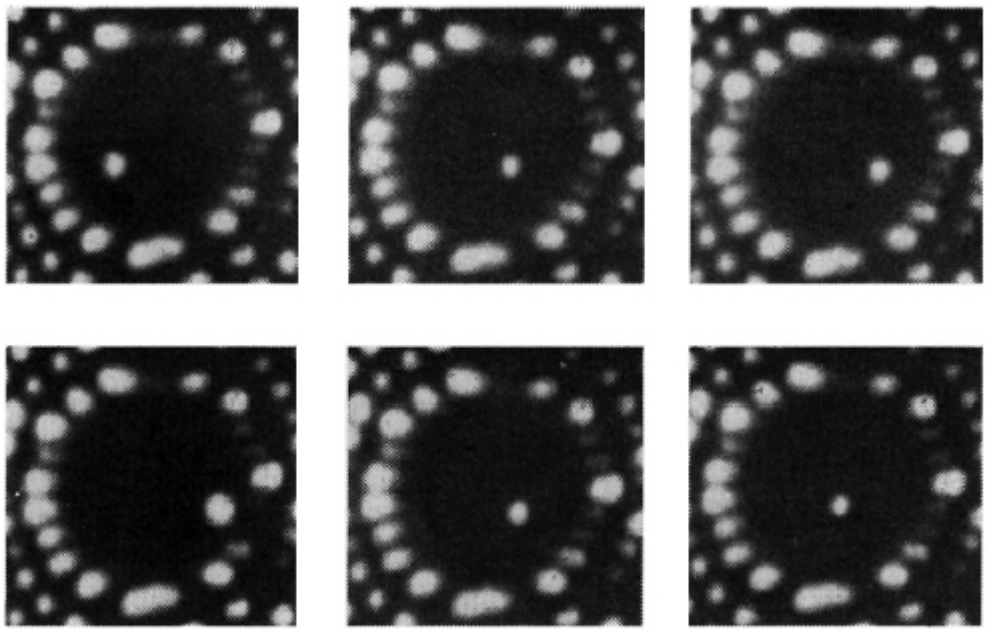

FIG. 2. Movement of a single rhenium atom over W(211) as observed in the field ion microscope. Diffusion along [$\bar{1}$11] channel occurs during 30 s intervals at T ≈ 351 K without any applied field. Observations at ≈20 K.

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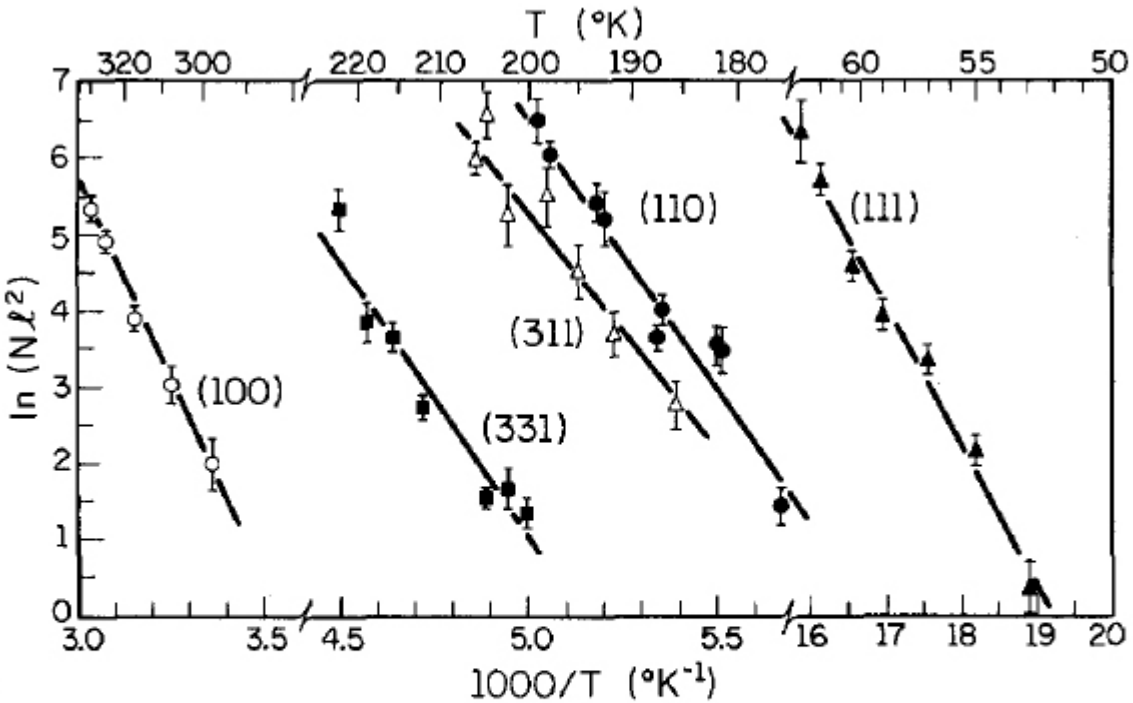

FIG. 10. Temperature dependence of self-diffusion on rhodium planes. On (110), (311), and (331), diffusion is one dimensional along [110]; on (111), (100), diffusion is two dimensional. The diffusion interval is 3 min, N is the number of jumps per interval, and l is the jump distance.

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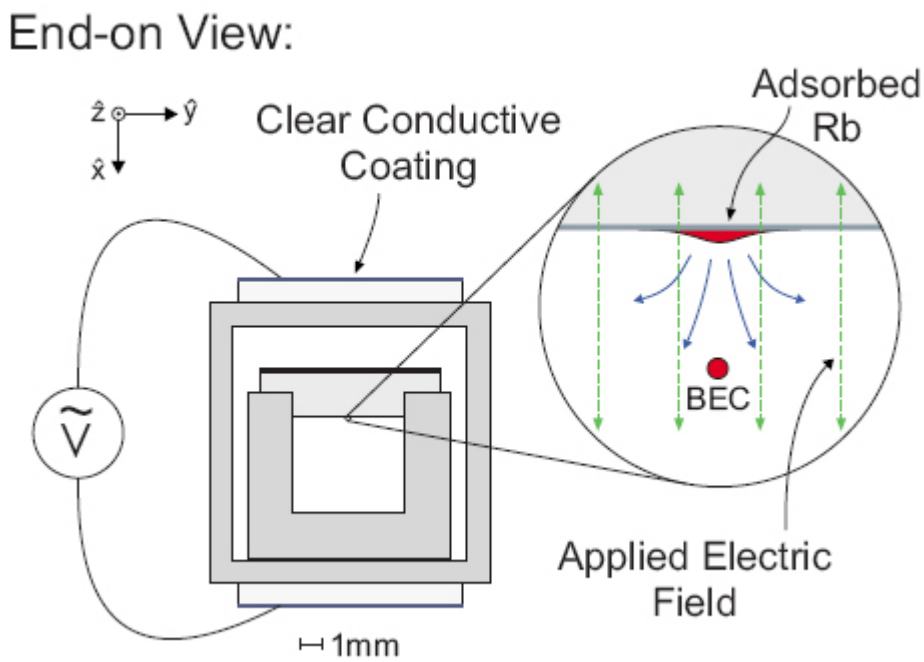
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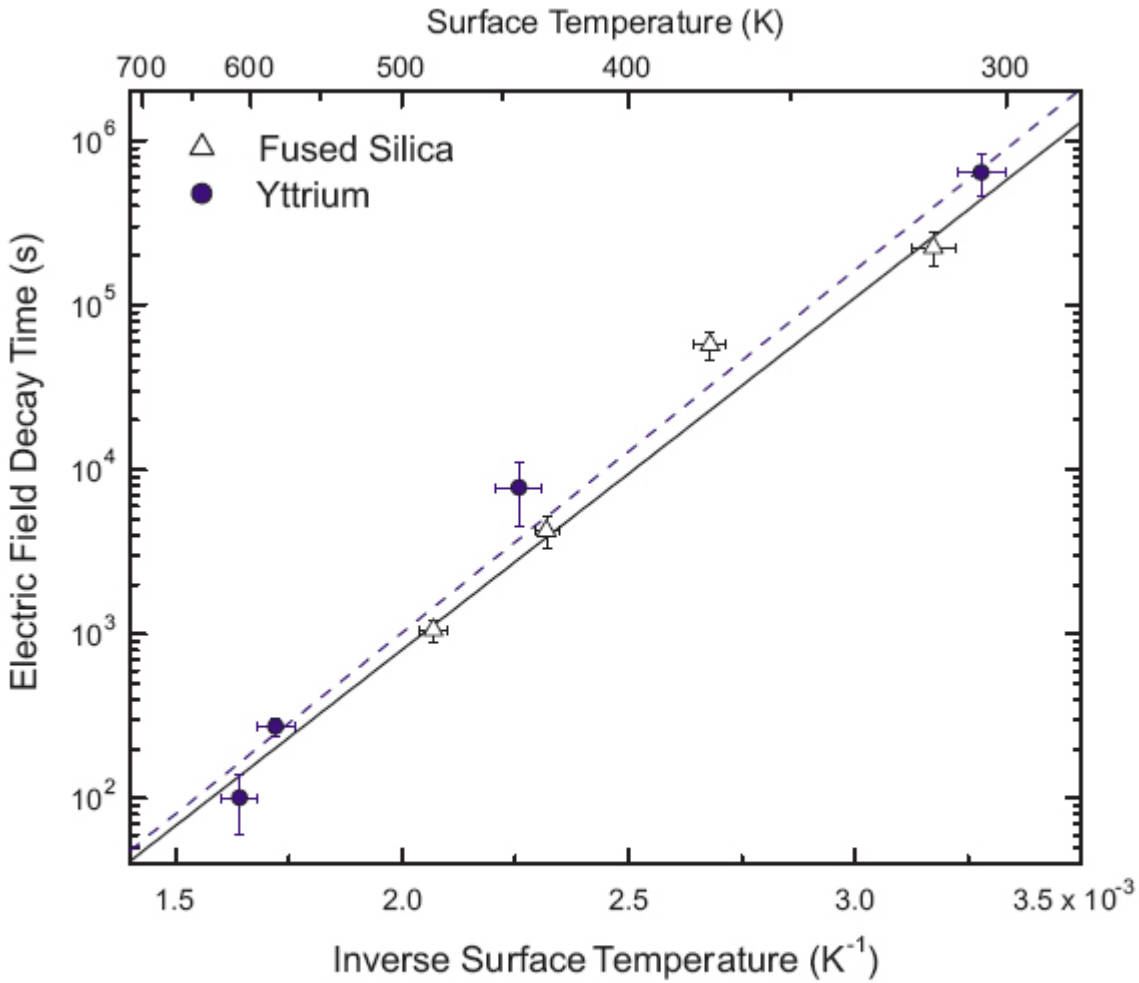

FIG. 6. (Color online) Decay time of the stray electric field as a function of temperature for a fused silica substrate (open triangles) and an yttrium surface (blue filled circles).

LISA Gravitational Reference Sensor Conditions

Gold-coated sapphire electrodes, very mild bakeout

1 year under vacuum, ~ 10-5 Pa

~ 300 K, ~ 0.1 K temperature uniformity

~ 1.5 K annual temperature variations

Occasional solar proton events

Anisotropic contaminant flux from virtual leaks

Possible Conclusions

Time constants for work function variations due to motions of chemisorbed atoms are likely to be long.

Readjustments of work functions due to changes in the temperature distributions are likely to be small.

The Trento approach of periodically measuring the average potential difference for each electrode and compensating for it appears to be quite feasible.

Experience with LISA Pathfinder will give valuable information on time variations of work function differences.

However, for the longer LISA lifetime, measurements of changes in work functions under controlled conditions will be needed.