1. Tritium in gold

From ref [1]

- Location of implanted tritium

#1 : interstitial lattice

#2 : dislocations(crystal mismatch or oxidized site)

#3 : vacancies(gold)

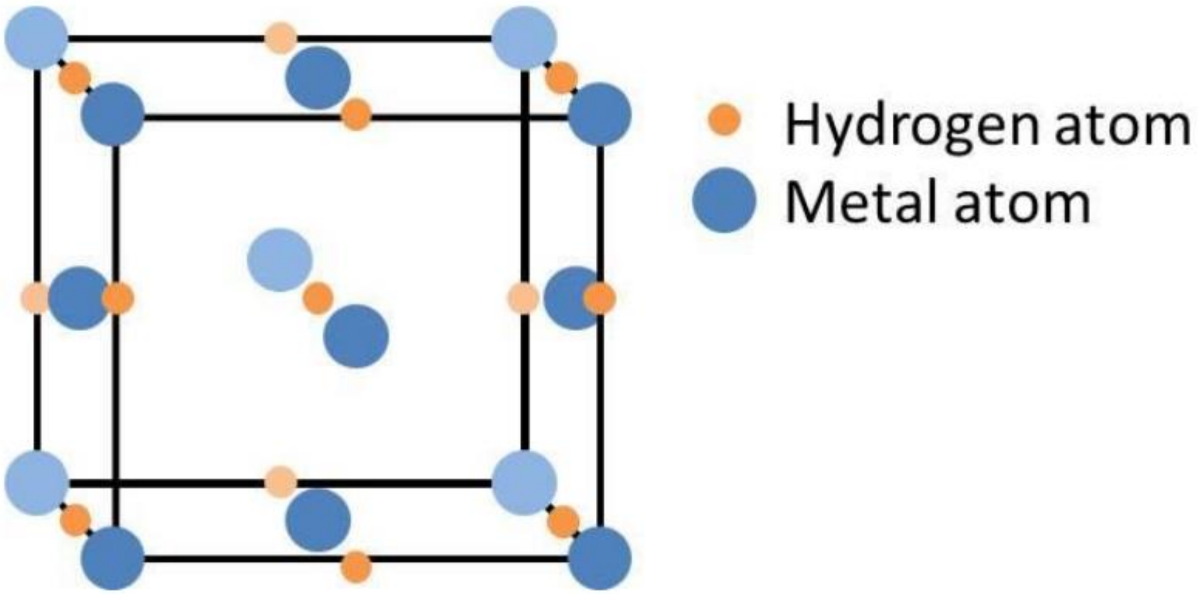


Figure 2.2.1; Illustration of possible hydrogen binding to octahedral sites in an FCC crystal lattice

[1] "On the Interaction of Tritium with the Surfaces of Aluminum, Copper, Stainless Steel (type 316), and Gold", Matthew Sharpe(2016)

From ref [2]

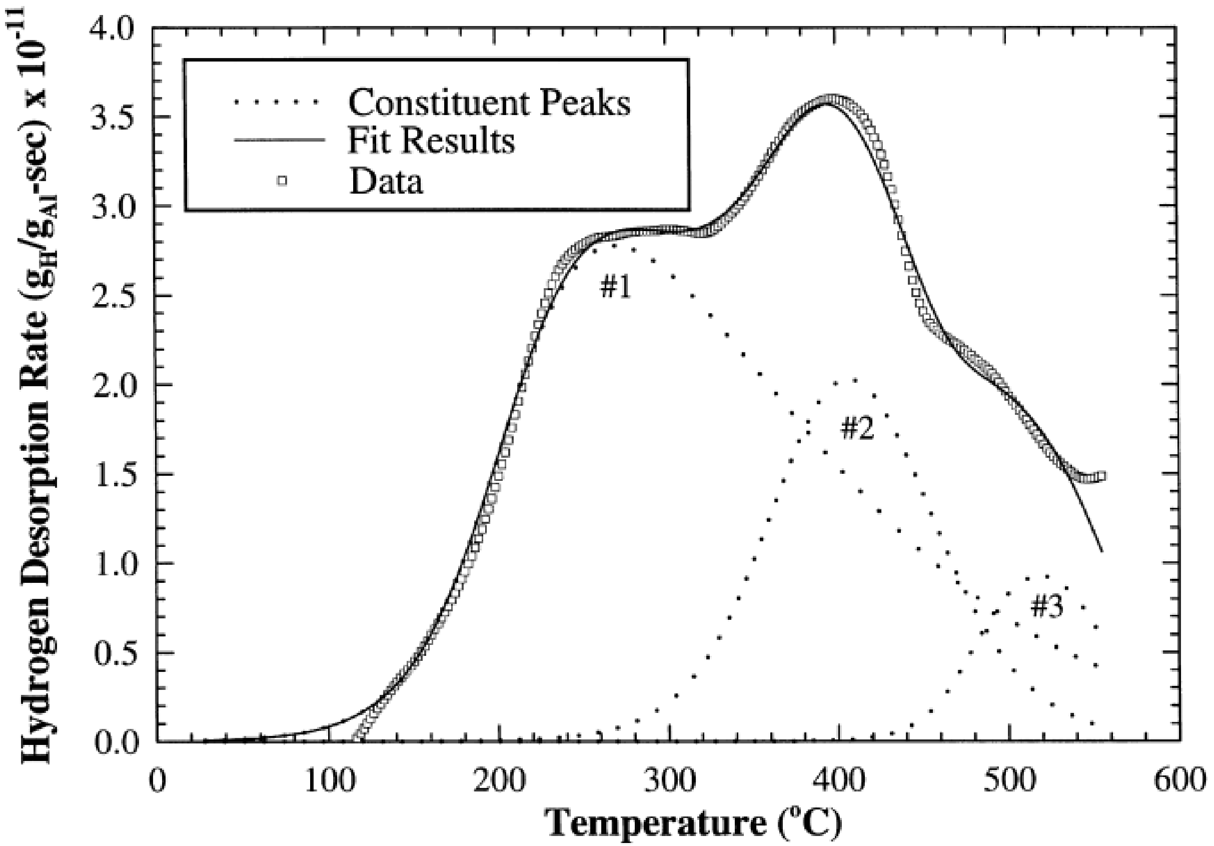


Fig. 7. A typical ramped desorption scan and peak fit to the data showing hydrogen release from three distinct trap states in polycrystalline 99.999 wt% aluminum.

#1 : interstitial lattice
#2 : dislocations(crystal mismatch or oxidized site)
#3 : vacancies(gold)

- Lattice binding energy is below $\sim 0.1eV$ (1000℃)
- So it is negligible
- For gold?

[2] G.A. Young, J.R. Scully, “THE DIFFUSION AND TRAPPING OF HYDROGEN IN HIGH PURITY ALUMINUM” Acta Materialia 1998, 46 (18), 6337-6349

2. Tritium beta spectrum [3]

$$\left({}^{3}H\right)_0 \rightarrow \left({}^{3}He^{1+}\right)_n \rightarrow \left({}^{3}He^{1+}\right)_0 \rightarrow \left({}^{3}He\right)_0$$

(1) (2) (3)

Beta decay De-excitation neutralization

(1)

- $E_e = m_e + Q_n - E_\nu$
- $Q_n = Q^* - E_{rec} + \Delta E_{0n}$

- Mass difference of bare nucleus(${}^{3}H^{+} \rightarrow {}^{3}He^{2+}$) $Q^* = 18.5882(12) keV$ [4]
- $E_{rec} = 3.44 eV$
- $\Delta E_{0n} = \epsilon_1^1(0) - \epsilon_2^1(n)$, *where* $\epsilon_Z^n(m)$ is m^{th} electron eigenstate energy of atom of nucleus charge Z and n bound electrons

- Transition probability(w_{0n}) : assume wave-function of bound electron remain intact during the decay process
  -> maybe invalid in low energy region of beta electron

[3] J. Lindhard and P. G. Hansen “Atomic Effects in Low-Energy Beta Decay: The Case of Tritium”, PRL, Volume 57, Number 8(1986)
[4] Sz. Nagy et al. “On the Q-value of the tritium β-decay” , EPL (Europhysics Letters), Volume 74, Number 3(2000)

(2), (3)

- The moment of beta emission, beta electron feels coulomb repulsion from the bound electron at the nucleus site of energy $\Delta E_{0n} (\because V_s = \Delta H)$

 -> shift E_e to $E_e + \Delta E_{0n}$

- Experimentally, de-excitation(2) and neutralization(3) energy(E'_{n0}) adds to the beta electron's

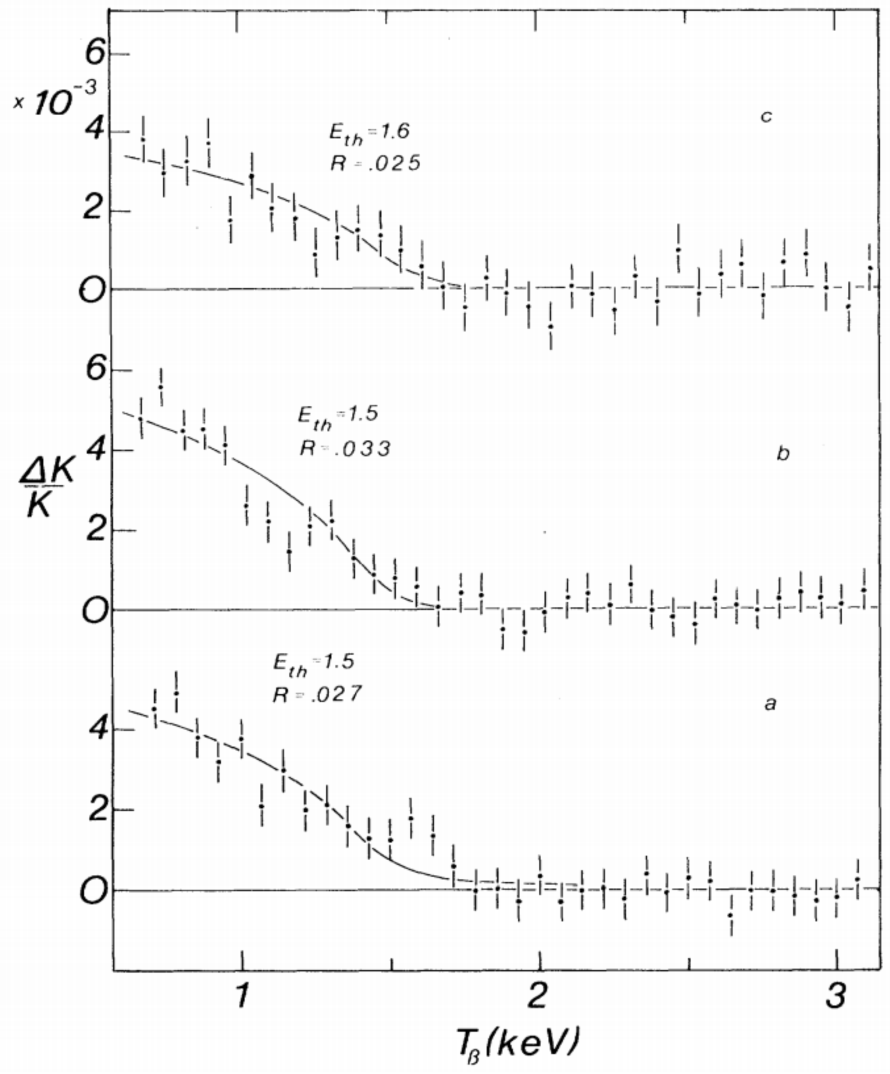
 -> shift E_e to $E_e - E'_{n0}$

Integrate above two correction into replacement of E_e to $E_e - \Delta E^*_{0n}$, $\Delta E^*_{0n} = E'_{n0} - \Delta E_{0n}$

$$\frac{d\lambda}{dE_e} = CF(Z_f, E_e)\sqrt{E_e{}^2 - m_e{}^2}E_e\sqrt{(Q - E_e)^2 - m_\nu{}^2}(Q - E_e)\Theta(Q - m_\nu - E_e)$$

$$\frac{d\lambda}{dE_e} = \sum_n w_n CF(Z_f, E_e - \Delta E^*_{0n})\sqrt{(E_e - \Delta E^*_{0n})^2 - m_e{}^2}(E_e - \Delta E^*_{0n})\sqrt{(Q + E'_{n0} - E_e)^2 - m_\nu{}^2}(Q + E'_{n0} - E_e)\Theta(Q + E'_{n0} - m_\nu - E_e)$$

3. To do [5] [6]



- Draw spectral effect of above corrections and further corrections(radiative..)
- Check the J. J. Simpson's result

  (17keV, 1 – 2% mixing)
- Search other solid state effect on the energy distribution

[5] J. J. Simpson "Evidence of Heavy-Neutrino Emission in Beta Decay", PRL, Volume 54, Number 17 (1985)
[6] C. K. Hargrove et al. "Measurement of the screening potential in 3H b decay", PRC, Volume 60, 034608 (1998)