Rédox et surface du verre

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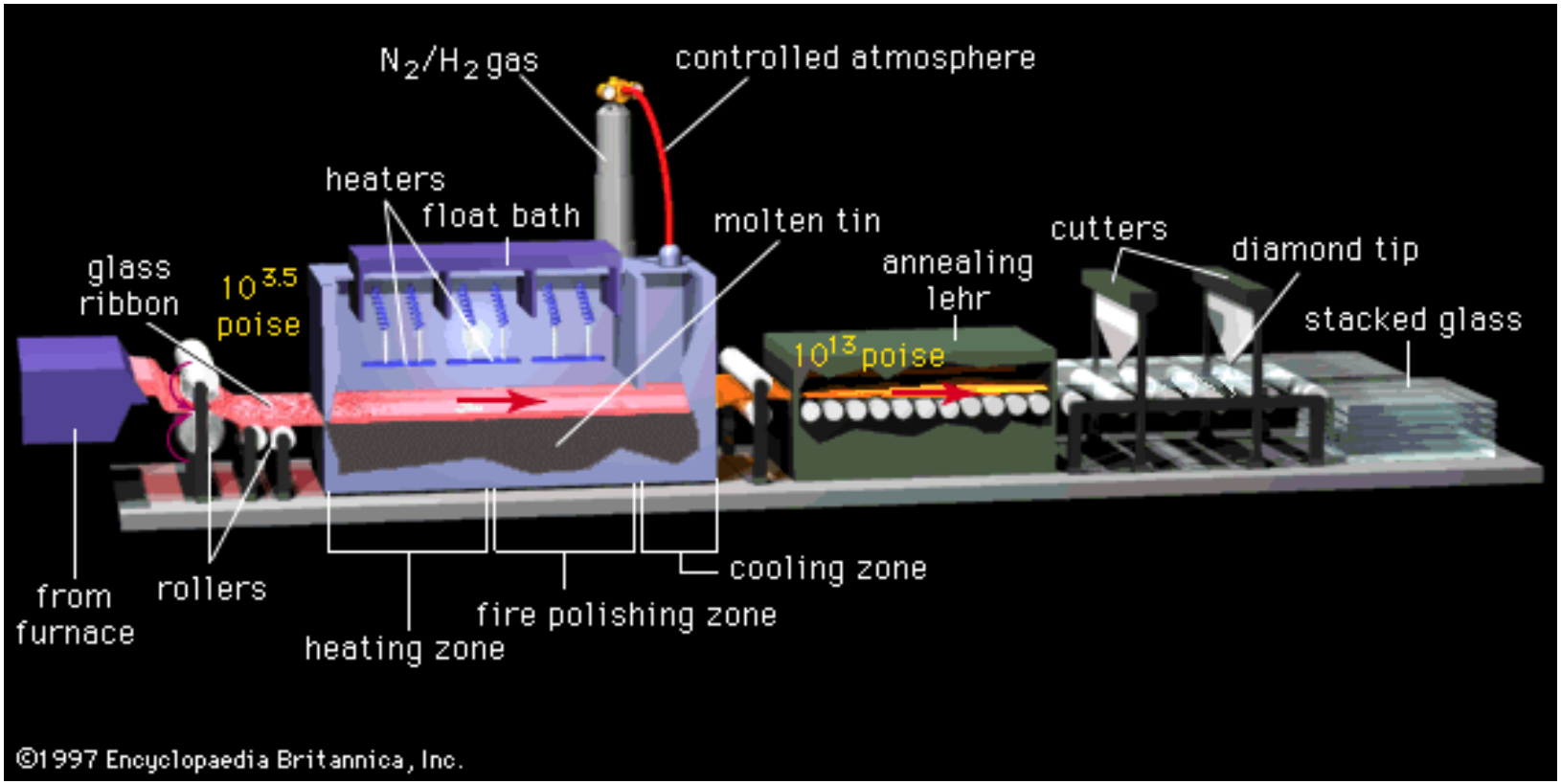
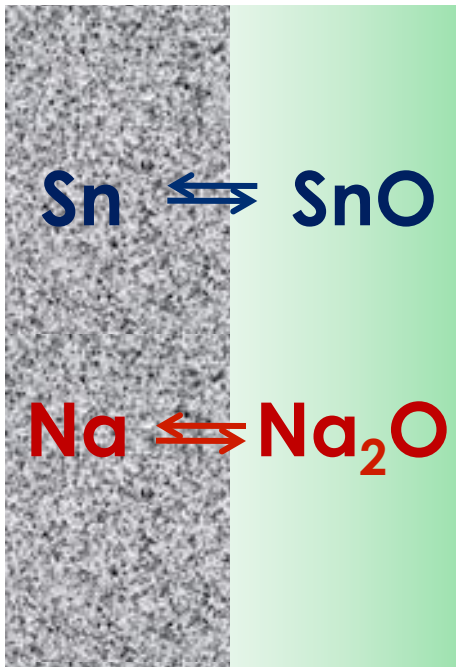
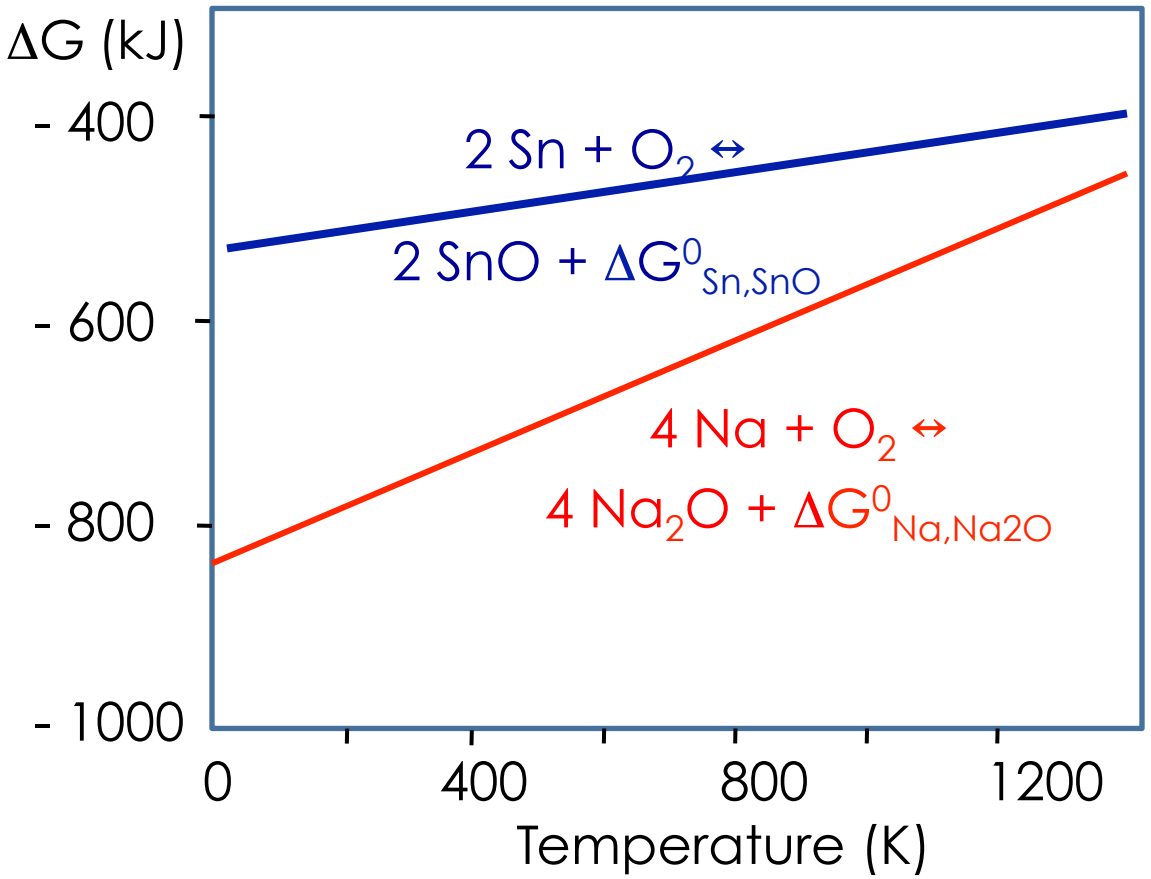
Le Rédox, 21-22 mars 2013, Nancy

Float process

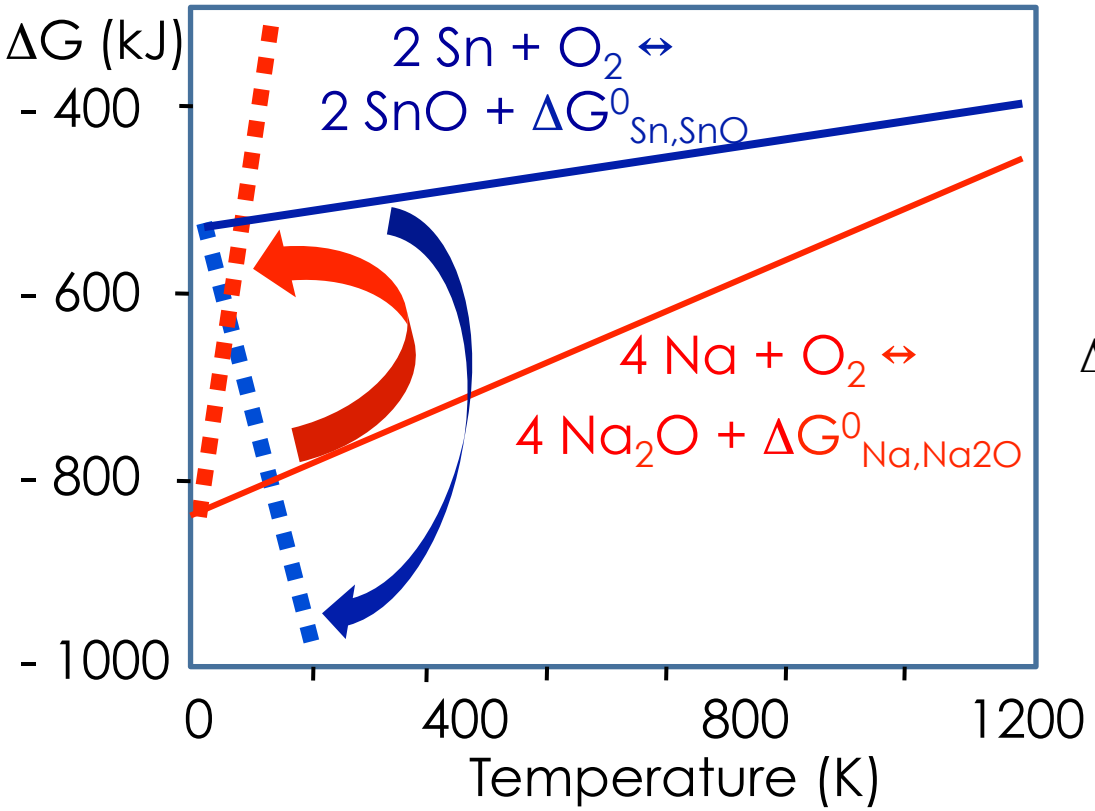


Interface between liquid tin and molten glass





Free energy at the interface between liquid tin and molten glass



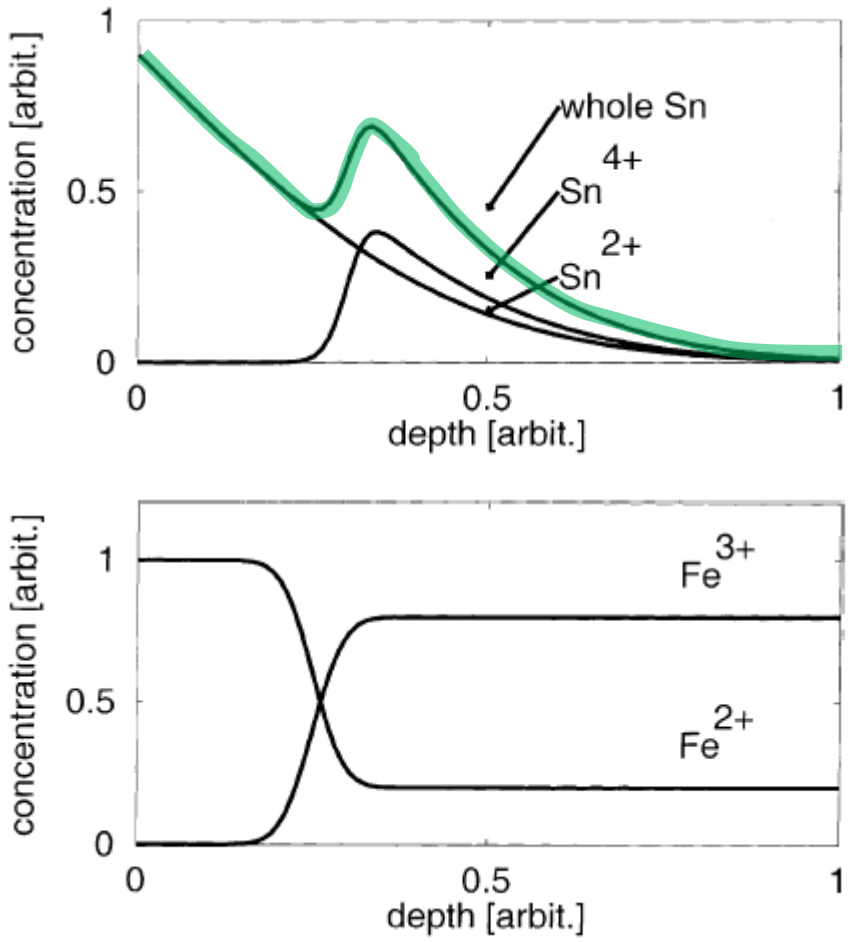
$$\Delta G = \Delta G^0 + RT \ln \frac{\prod_i a_i^{n_i}\ products}{\prod_i a_i^{n_i}\ reactants}$$

$$\Delta G_{Na,Na_2O} = \Delta G^0_{Na,Na_2O} + RT \ln \frac{a^2_{Na_2O}}{a^4_{Na}\, pO_2}$$

$$\Delta G_{Sn,SnO} = \Delta G^0_{Sn,SnO} + RT \ln \frac{a^2_{SnO}}{a^2_{Sn}\, pO_2}$$

Cook and Cooper
J. Non-Cryst. Solids
249 (1999) 210

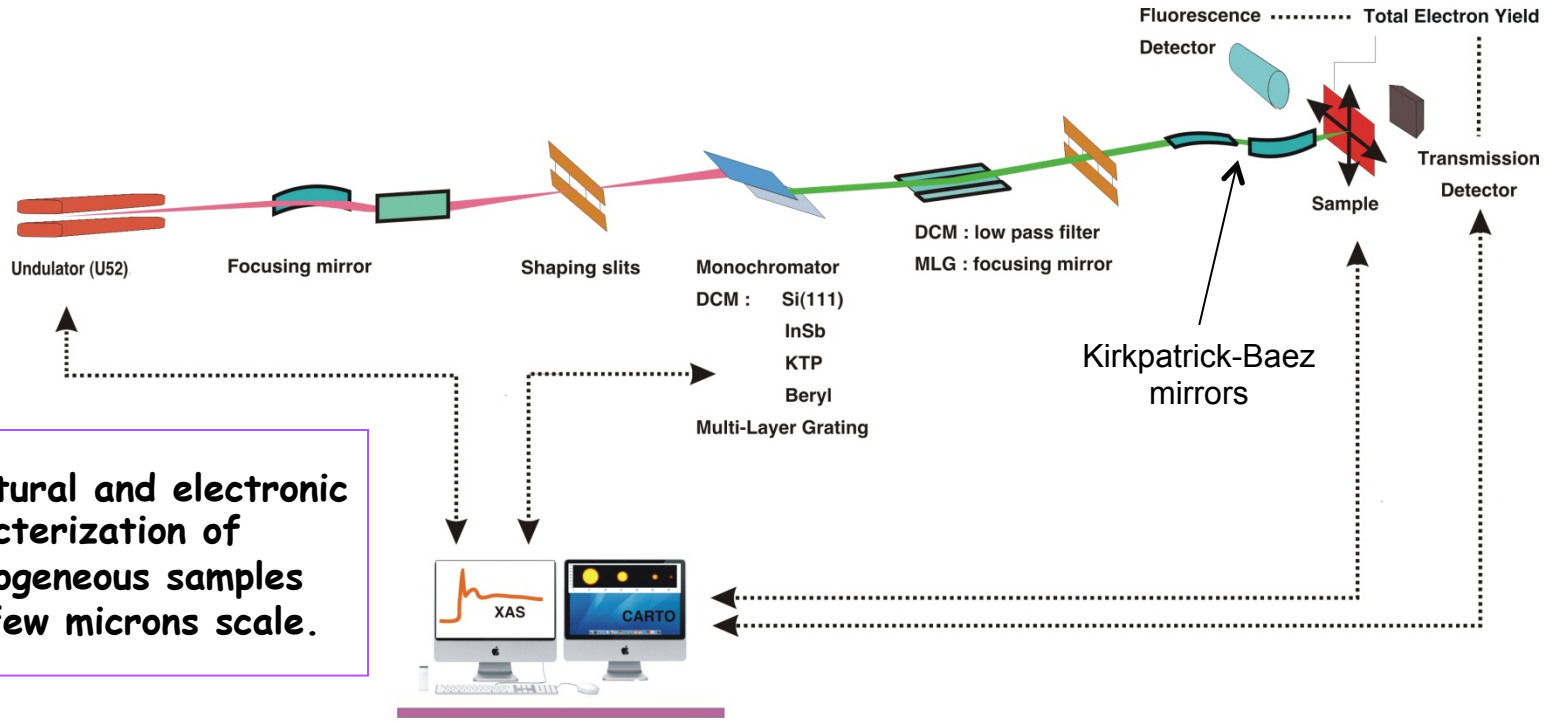
The tin hump



$Sn^{2+} + 2Fe^{3+} \rightleftharpoons Sn^{4+} + 2\,Fe^{2+}$

Frischat et al.
J. Non-Cryst. Solids
283 (2001) 246

LUCIA specifications



Structural and electronic characterization of inhomogeneous samples at a few microns scale.

- Energy domain : 0.8 - 8 keV:
  K edges from Na to Co; L and M edges above Ni
- micro- beam aspect : μ (XRF – XAS)
  spot size ➔ 2.5 x 2.5 μm^2: Heterogeneous or small samples
- High density of photons 10^{11}ph/sec: Diluted samples
- Linear (0-90°) and circular polarization: Oriented samples

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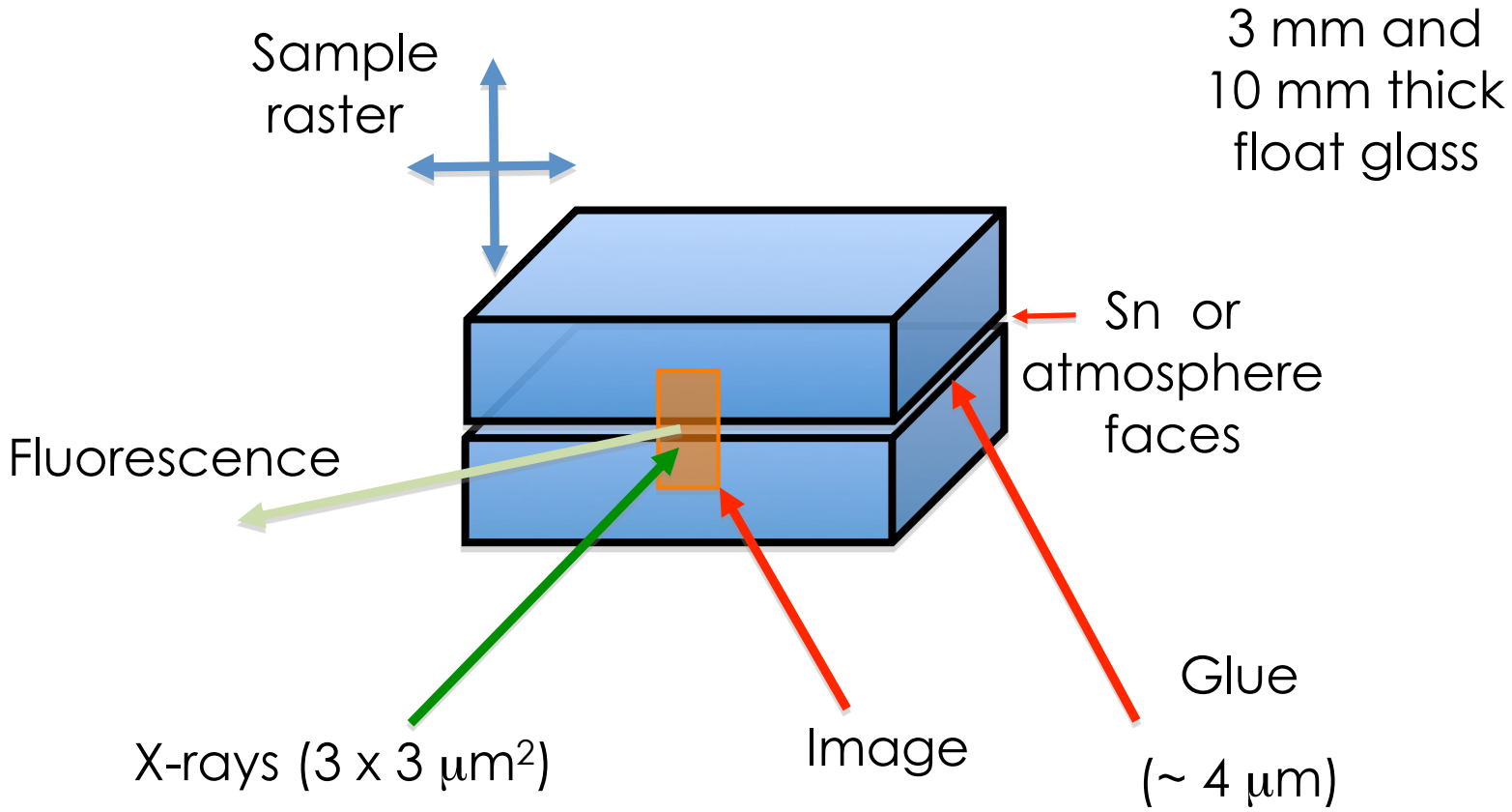
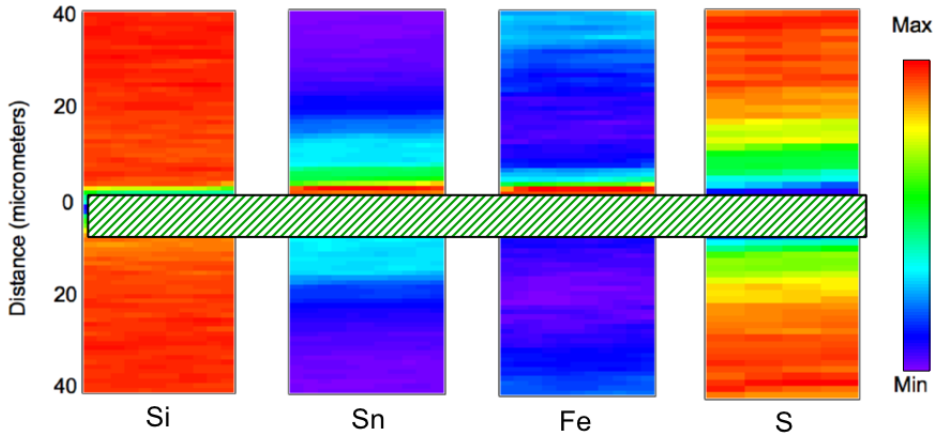
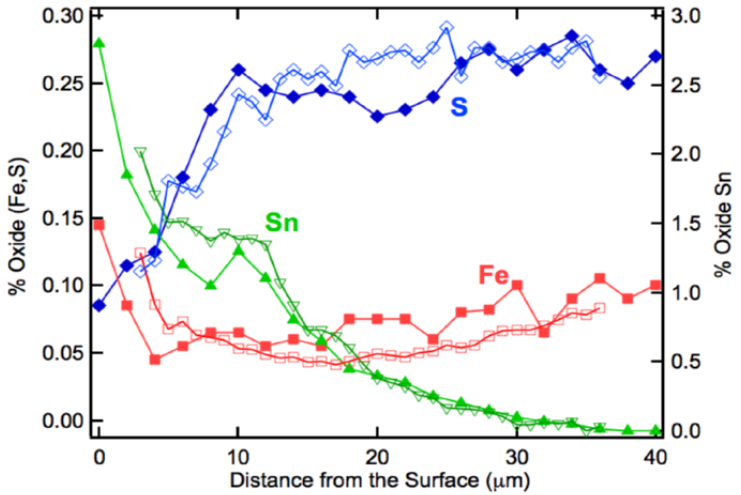
Samples for microscopy analysis



Concentration profile at the surface of float glass





10 mm thick float glass

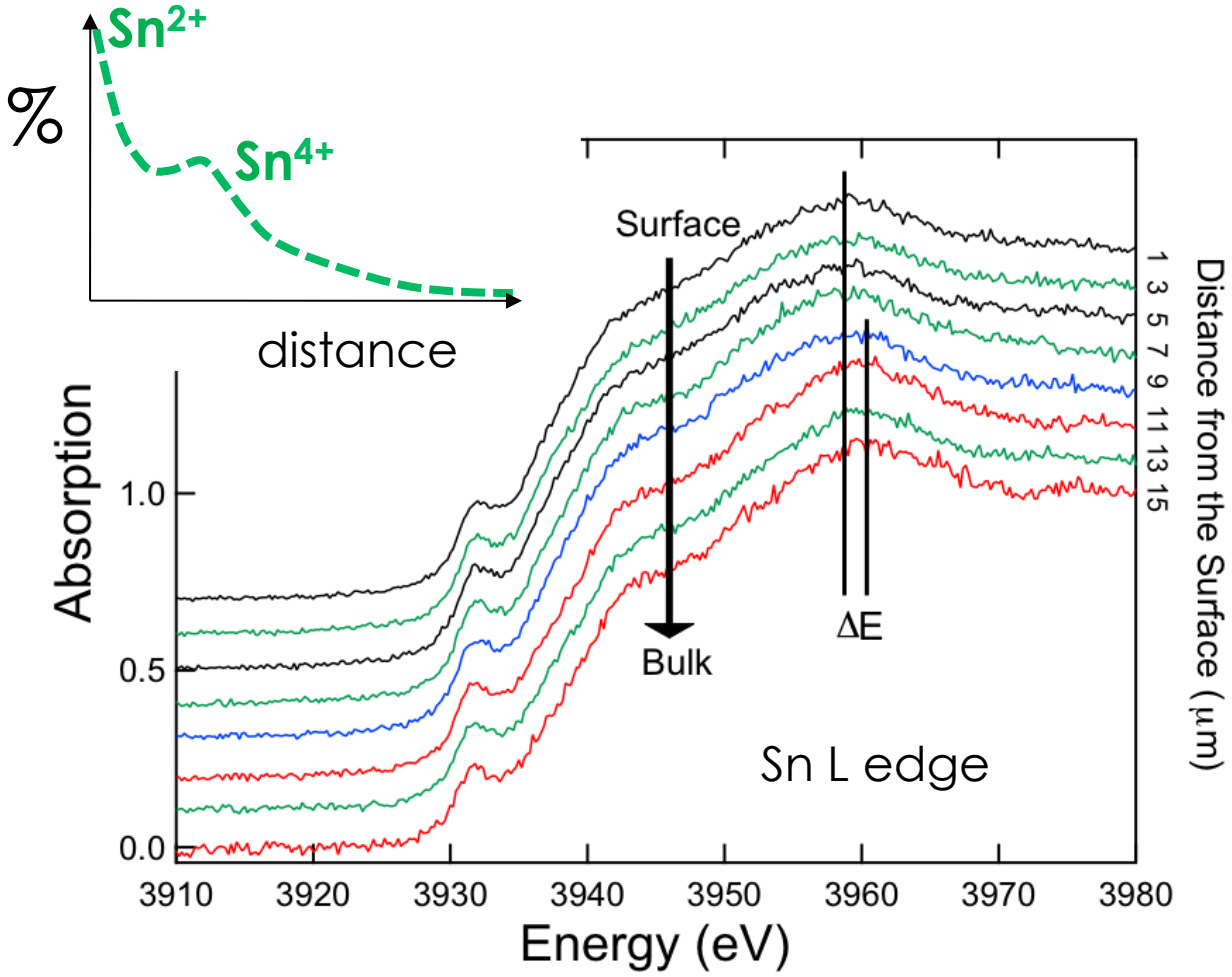
Sn L edge at 3990 eV to avoid calcium

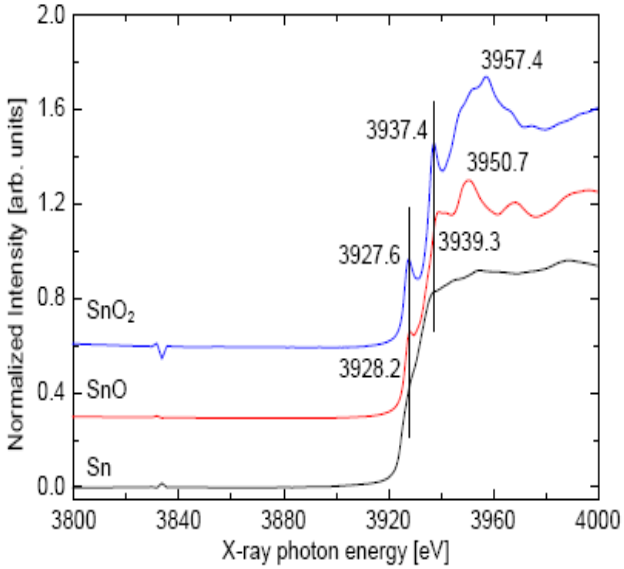
Fe K edge at 7130 eV

S K edge at 2500 eV

Lagarde et al.
J. Non-Cryst. Solids
357 (2011) 3200

Stannous and stannic ions





Zhenlin Liu et al,
J. Electron Spectrosc.
135 (2004) 155

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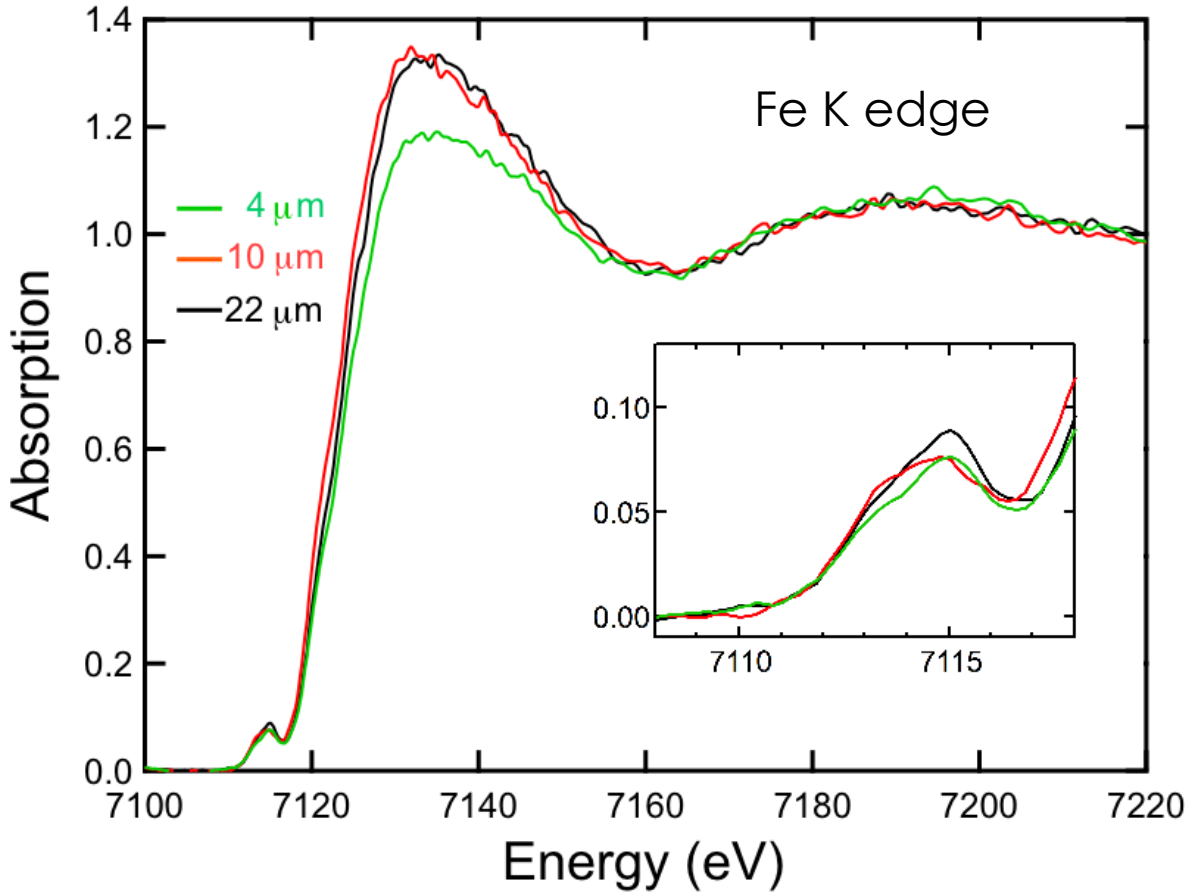
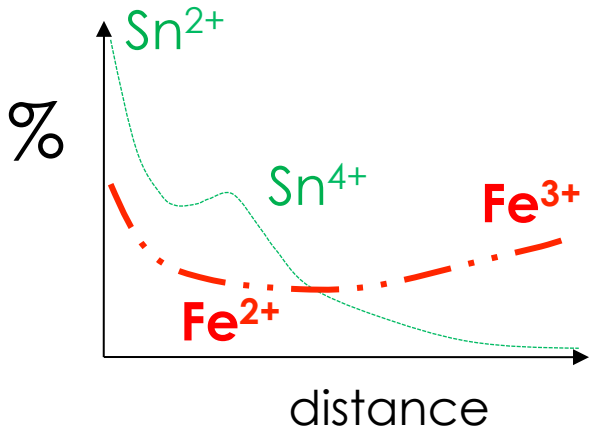
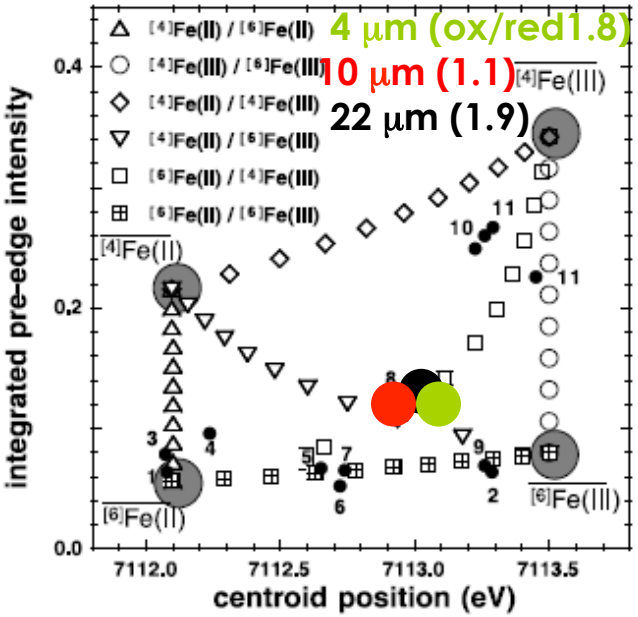
Iron reduction

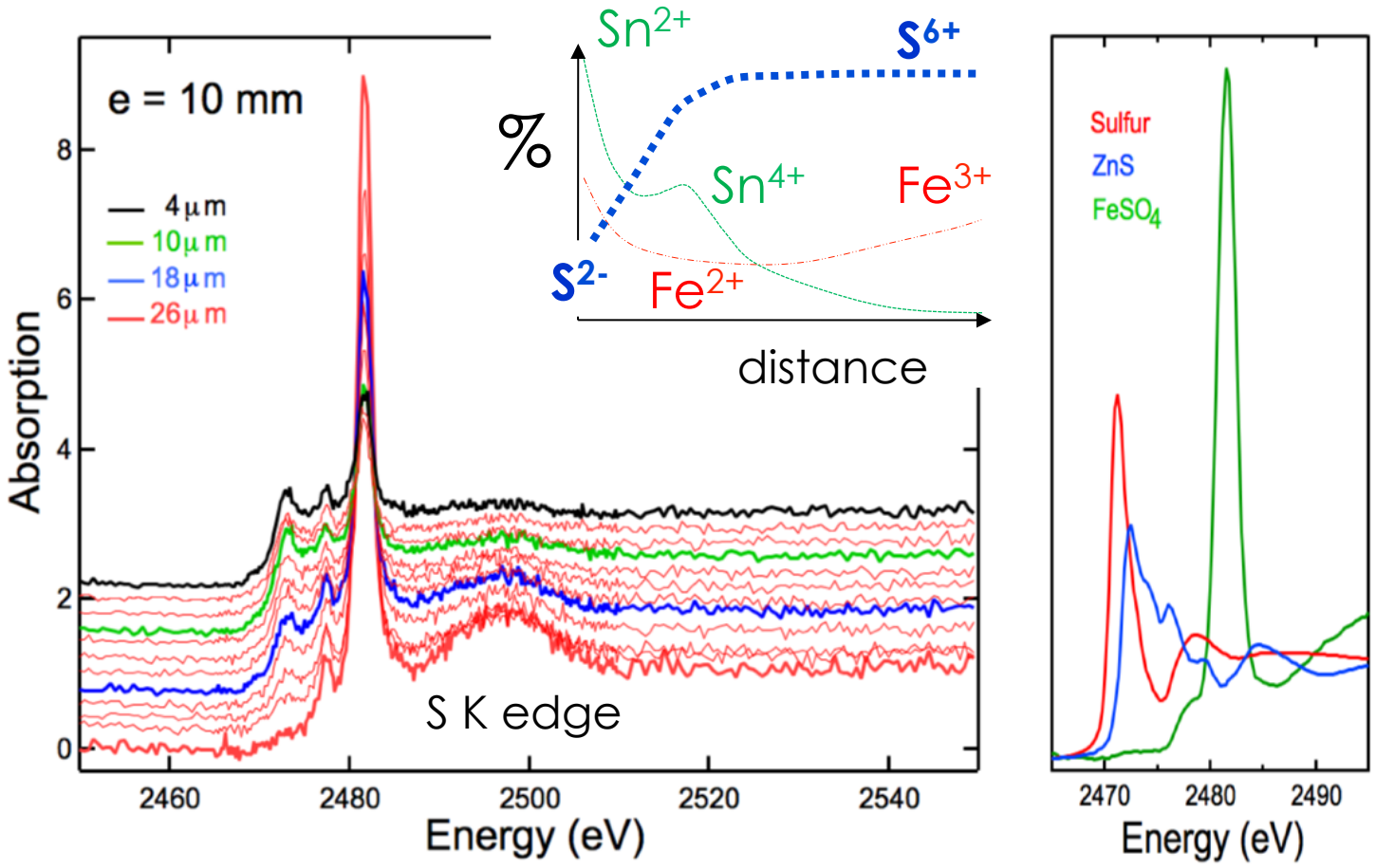




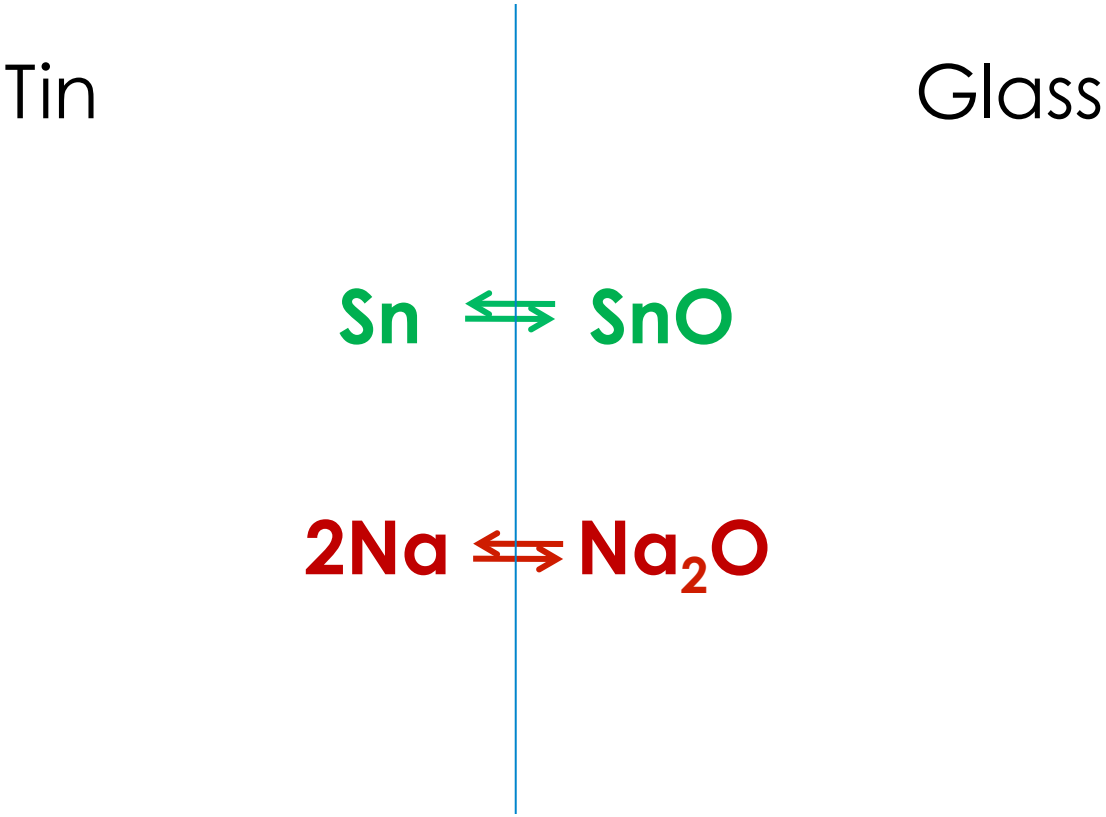


Wilke et al., Am. Min. 86 (2001) 714

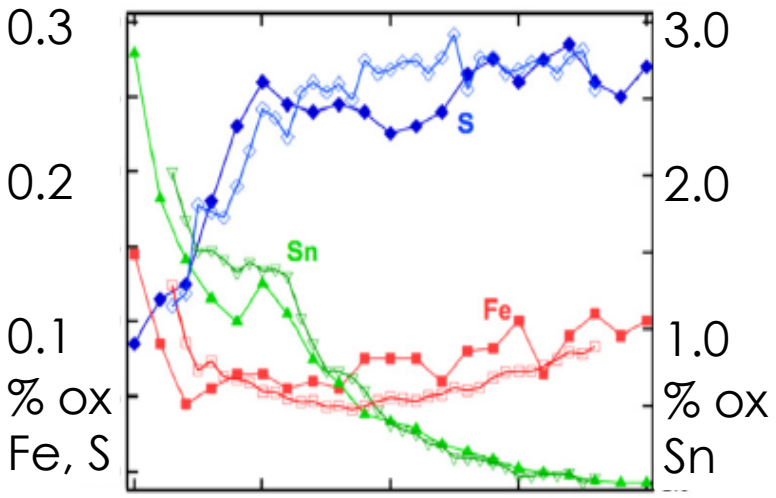
Surface sulfide

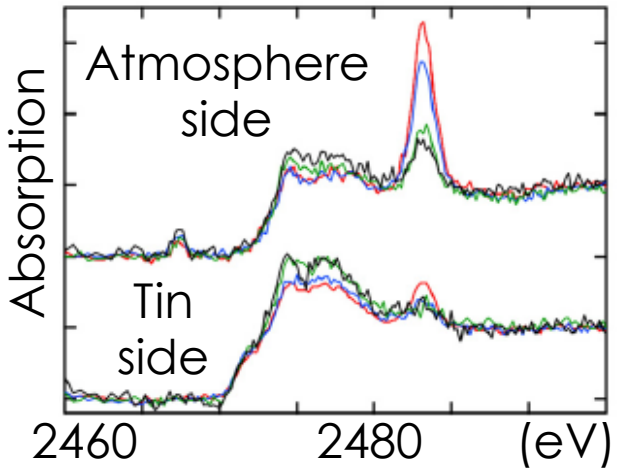


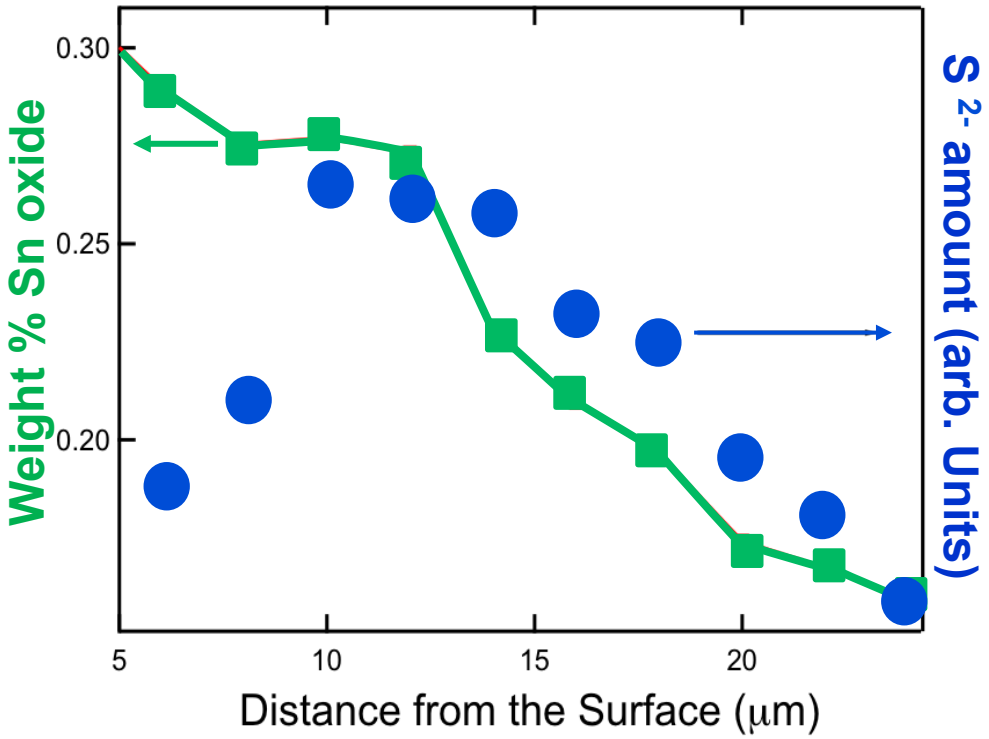
Tin diffusion



Redox reaction between tin and sulfur







$4\ Sn^{2+} \rightleftharpoons 4\ Sn^{4+}$

$S^{6+} \rightleftharpoons S^{2-}$

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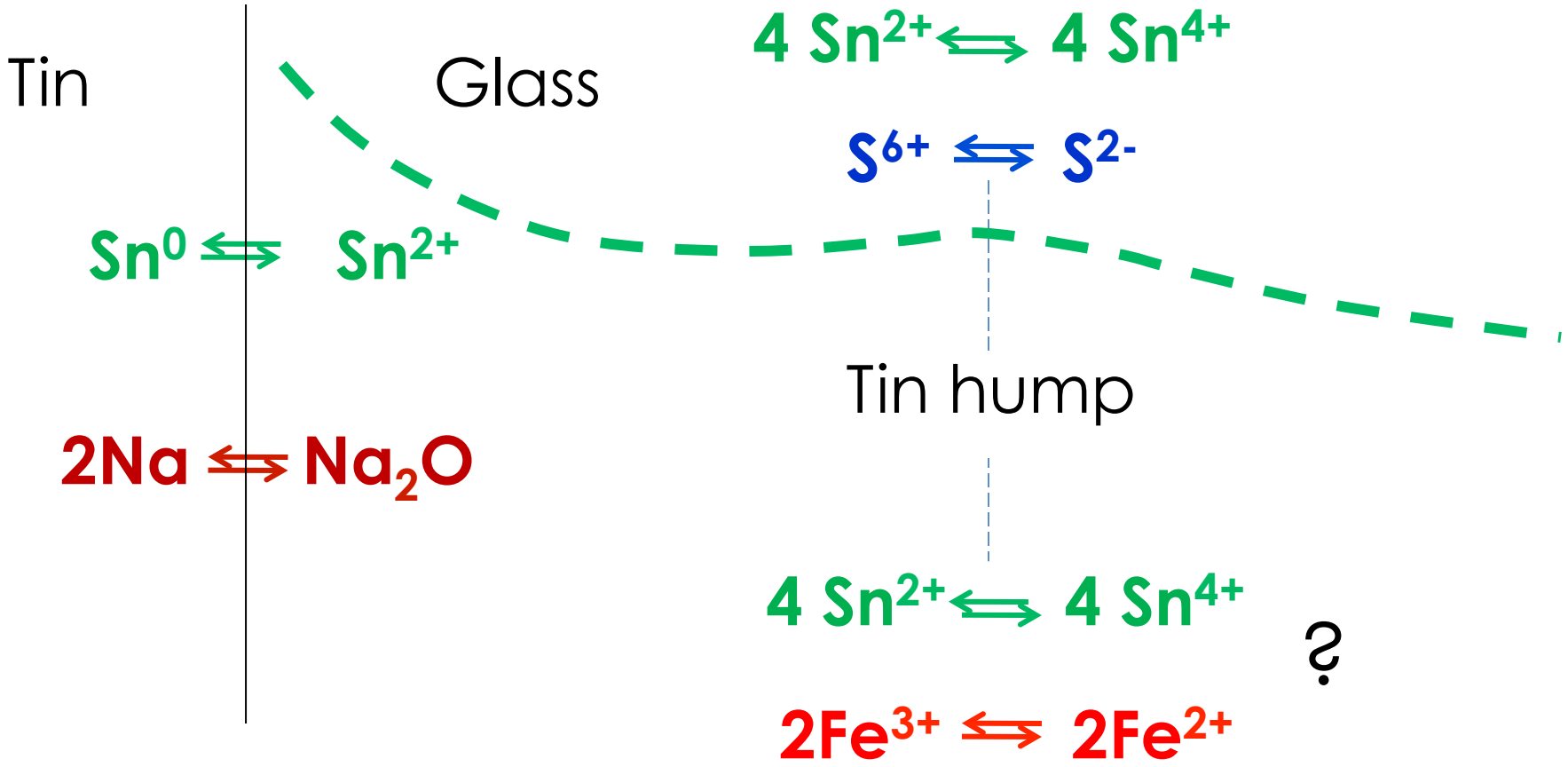
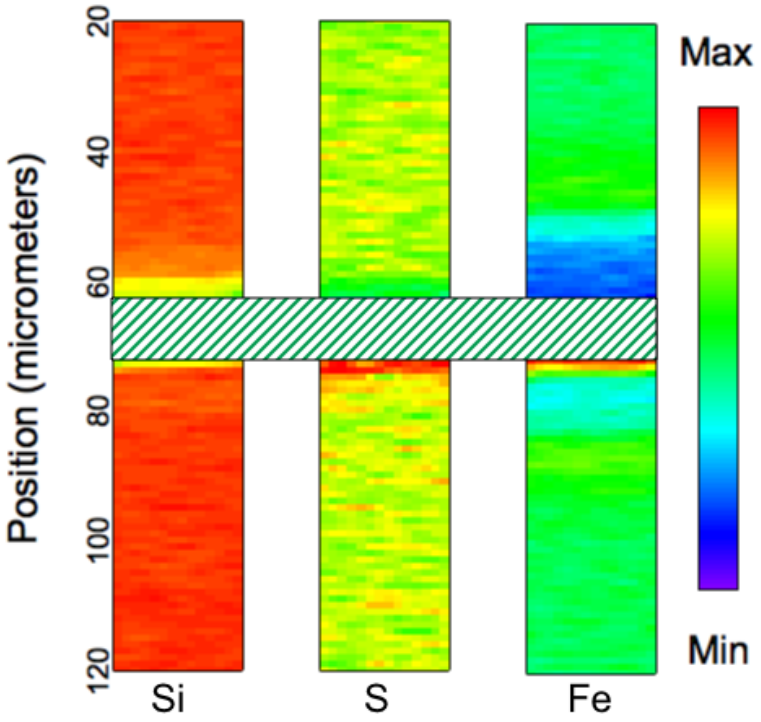
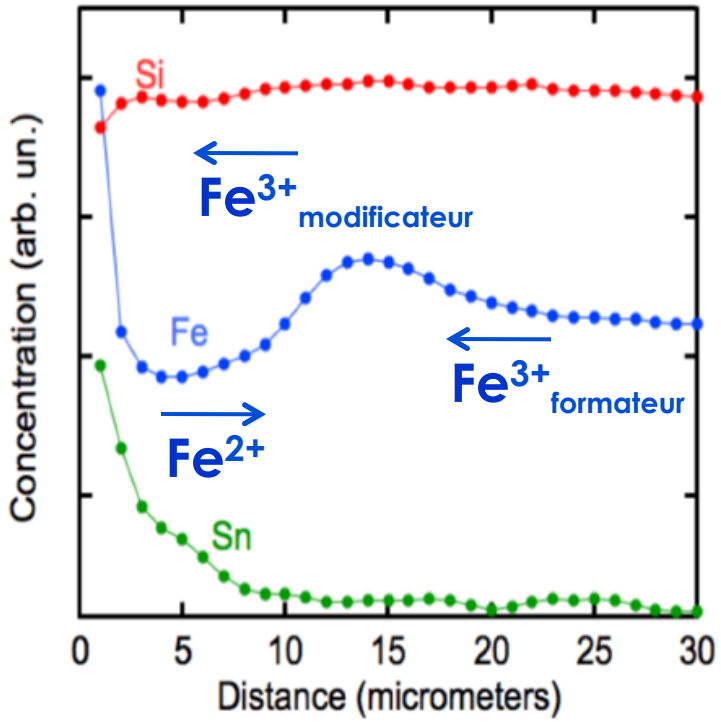
Origin of the redox reaction of iron?



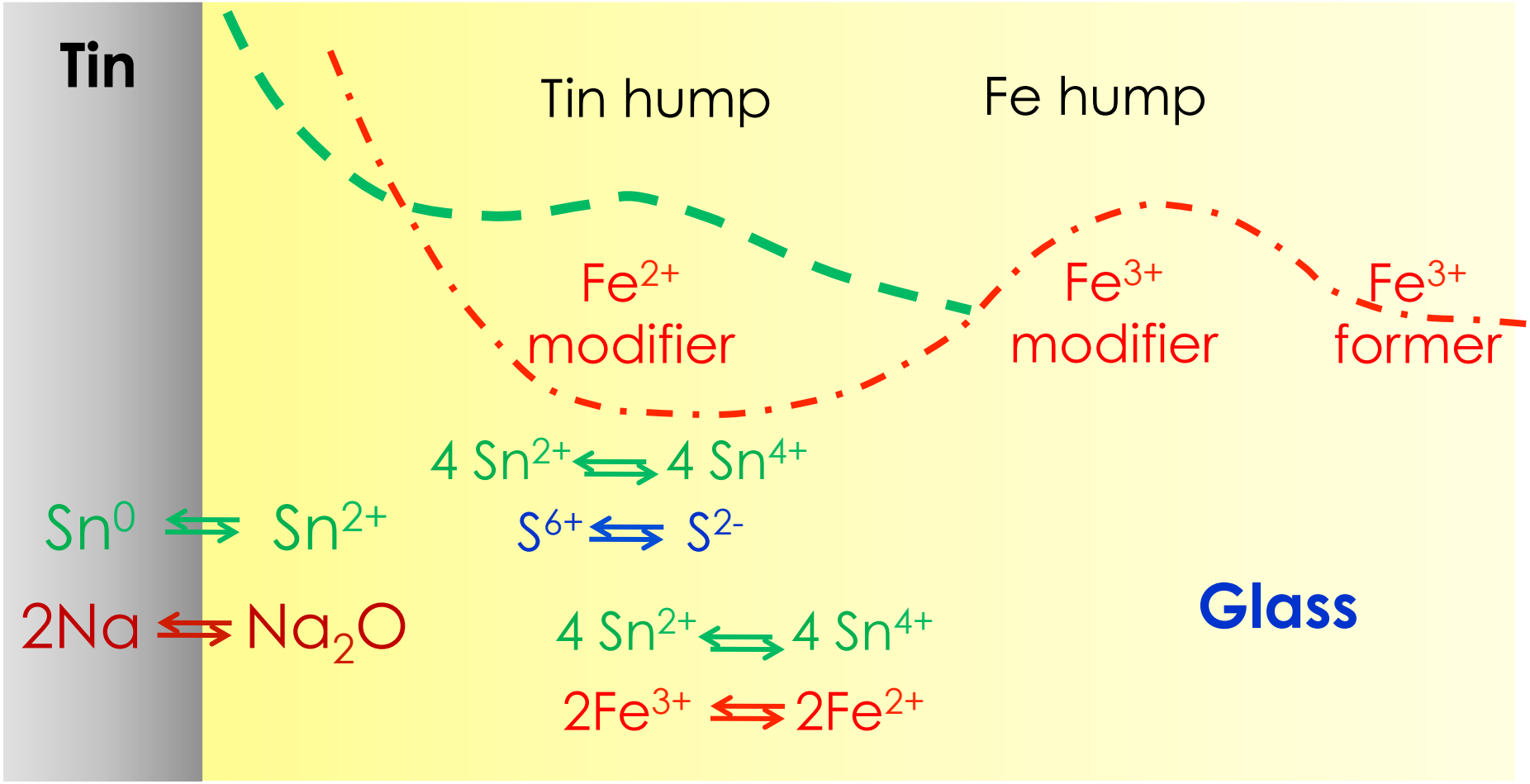
Iron hump





3 mm thick
float glass

A chemical echo of the tin hump



Aknowledgments

Marie-Hélène Chopinet

Patrick Garnier

Merci
de
votre attention