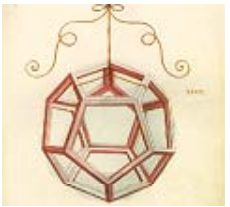
Air exposed unbaked surface: How low can be the SEY?



It is well known that the secondary electron yield increases upon air exposure

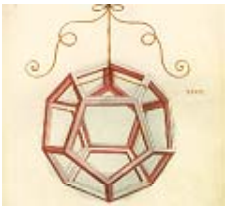
In case of application in non-bakable vacuum systems the surface will keep a strong memory of the air exposure.

TiN:

-- most of the published measurements of the SEY are made after air exposure, but the duration and "quality" not always well described

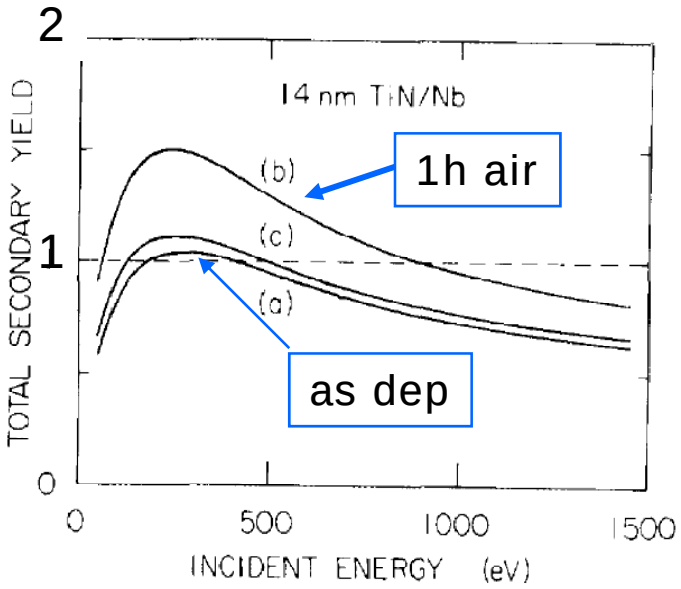
-- δ**max = 1.4-2.5** : part of the scattering is possibly due to storage in air before measurement more than to coating quality ► define accurately the handling after deposition!

Compare air exposed TiN versus copper

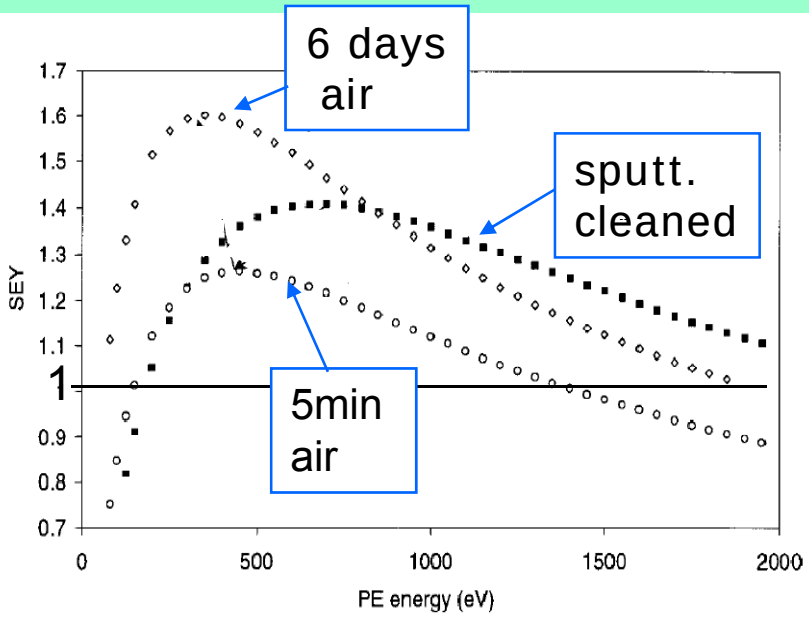


As deposited TiN is potentially better since it has a **δmax = 0.9-1.1** ; clean copper has 1.3

Upon air exposure the TiN yield increases to **δmax** = 1.5-2.5 ; for copper δmax =1.6-2.6



(E.L.Garwin et al. 1987)



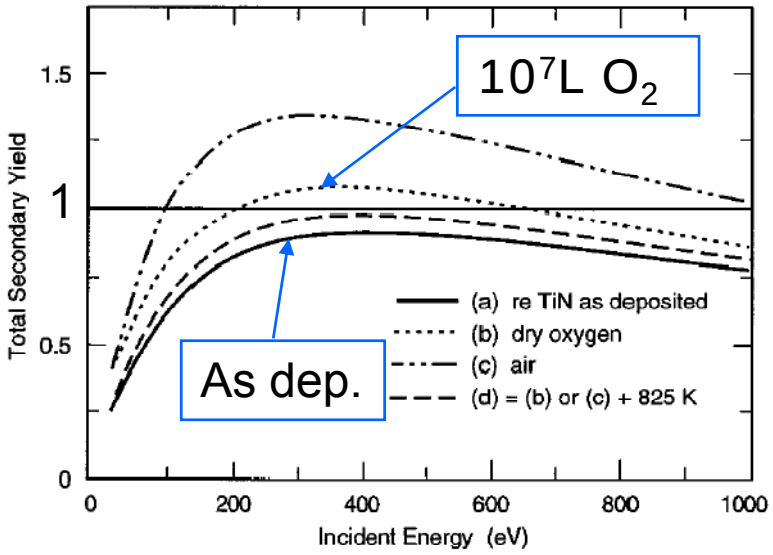
(Bojko, Henrist, Hilleret, Scheuerlein, 2000)

What happens during air exposure

1) Oxidation + 2) Adsorption of water and airborne hydrocarbons

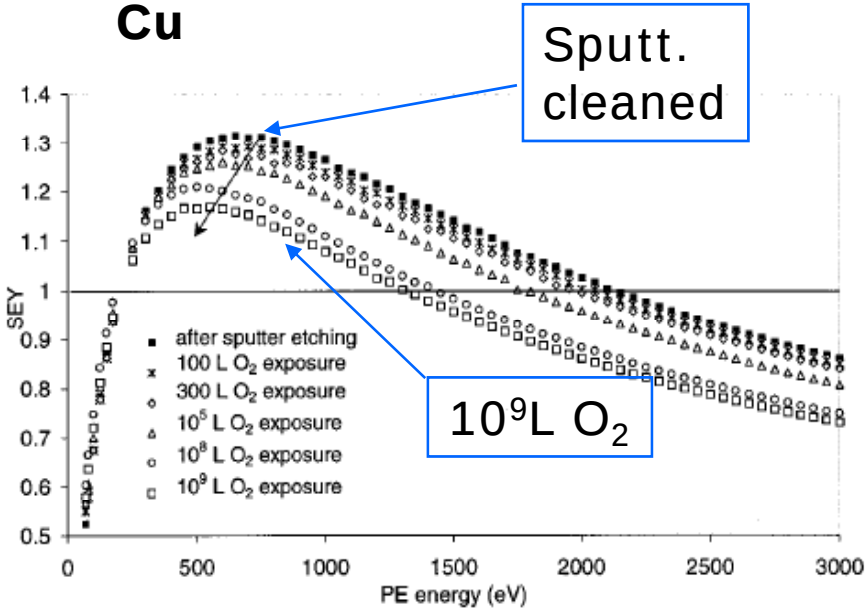
1) Oxidation is not the main reason for the increase of yield

TiN



(Prieto et al 1995)

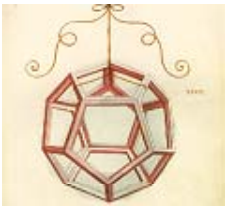
Cu



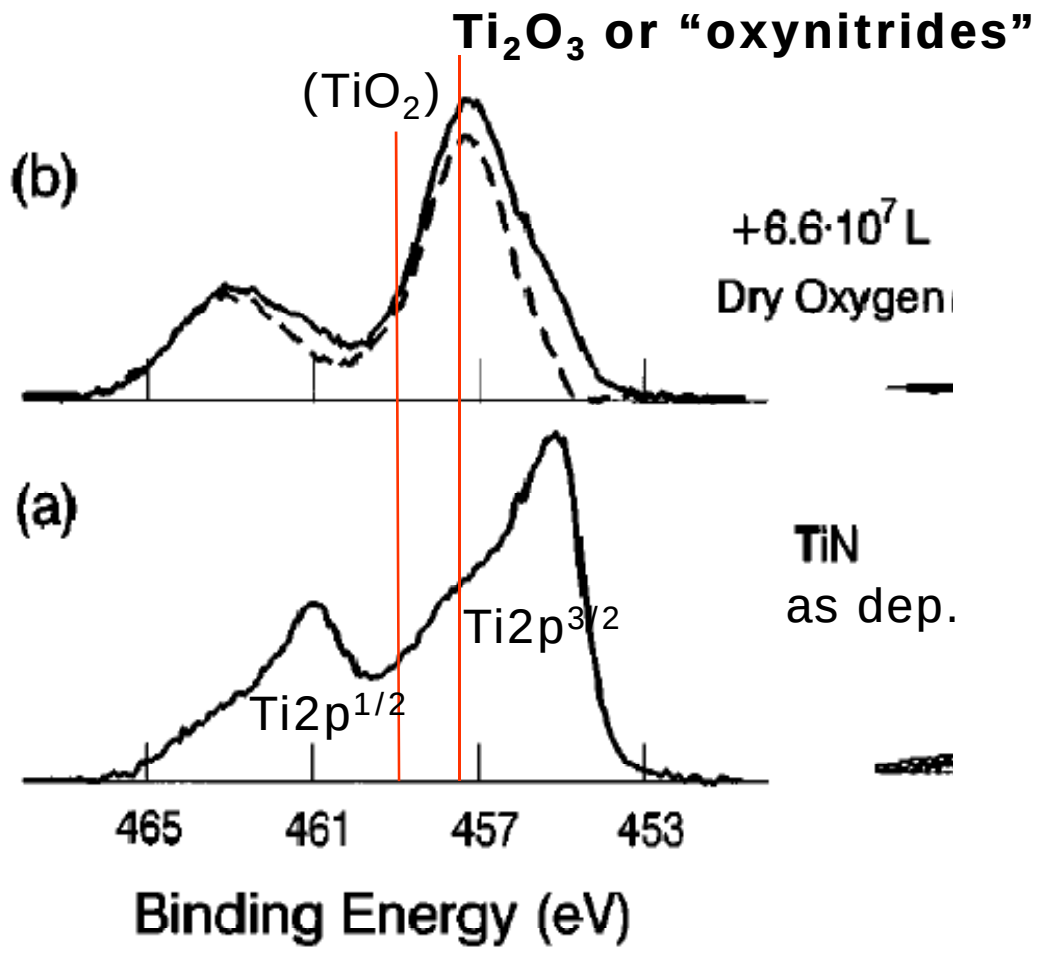
(J.Boiko et al. 2000)

We understand the tendency for copper: δmax of Cu_2O is 1.2, less than for clean Cu (1.3)

For TiN δmax increases moderately with oxygen exposure. The yield of TiO_2 is high (2.6), does this explain the increase for TiN?



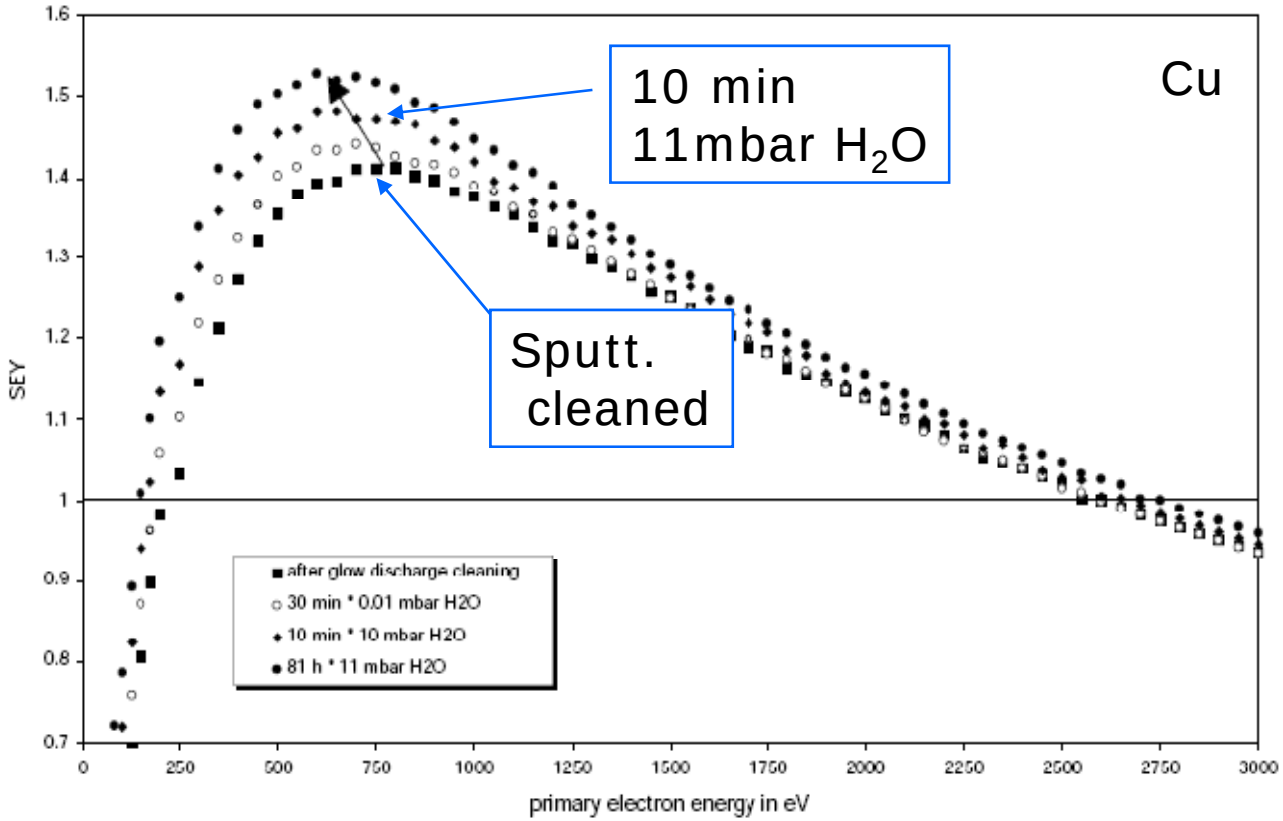
"Excursus": oxidation of TiN in XPS:



(Prieto et al 1995, Similar results by Kato et al.2005)

TiO_x or TiN_xO_y is present: the increase after oxygen exposure is moderate and due to those compounds

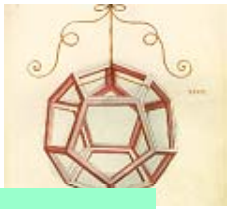
Adsorption of Water only:



Scheuerlein, 1997

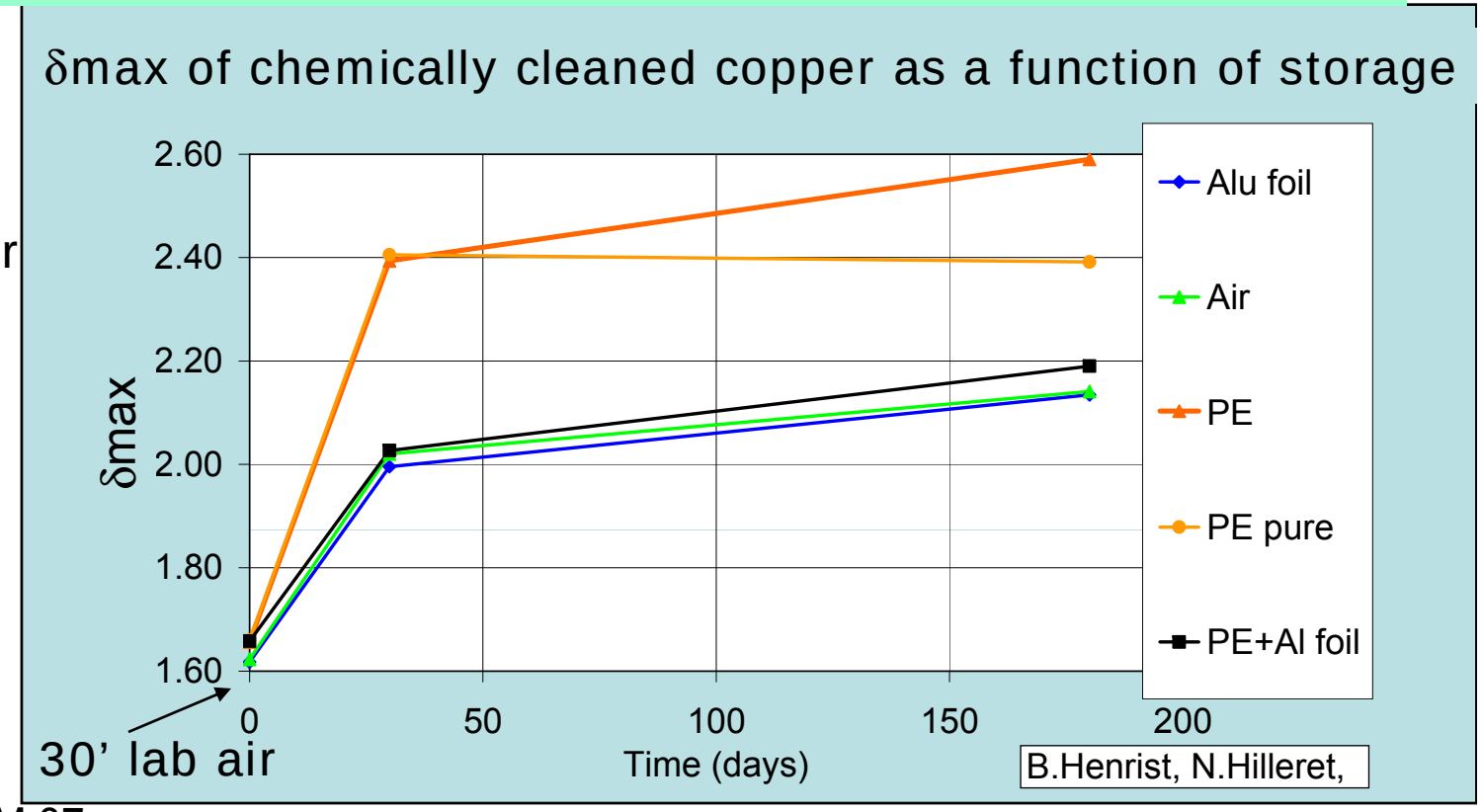
Justifies part of the increase for Cu. No data found for TiN

2) Air. Adsorption of hydrocarbons and water :

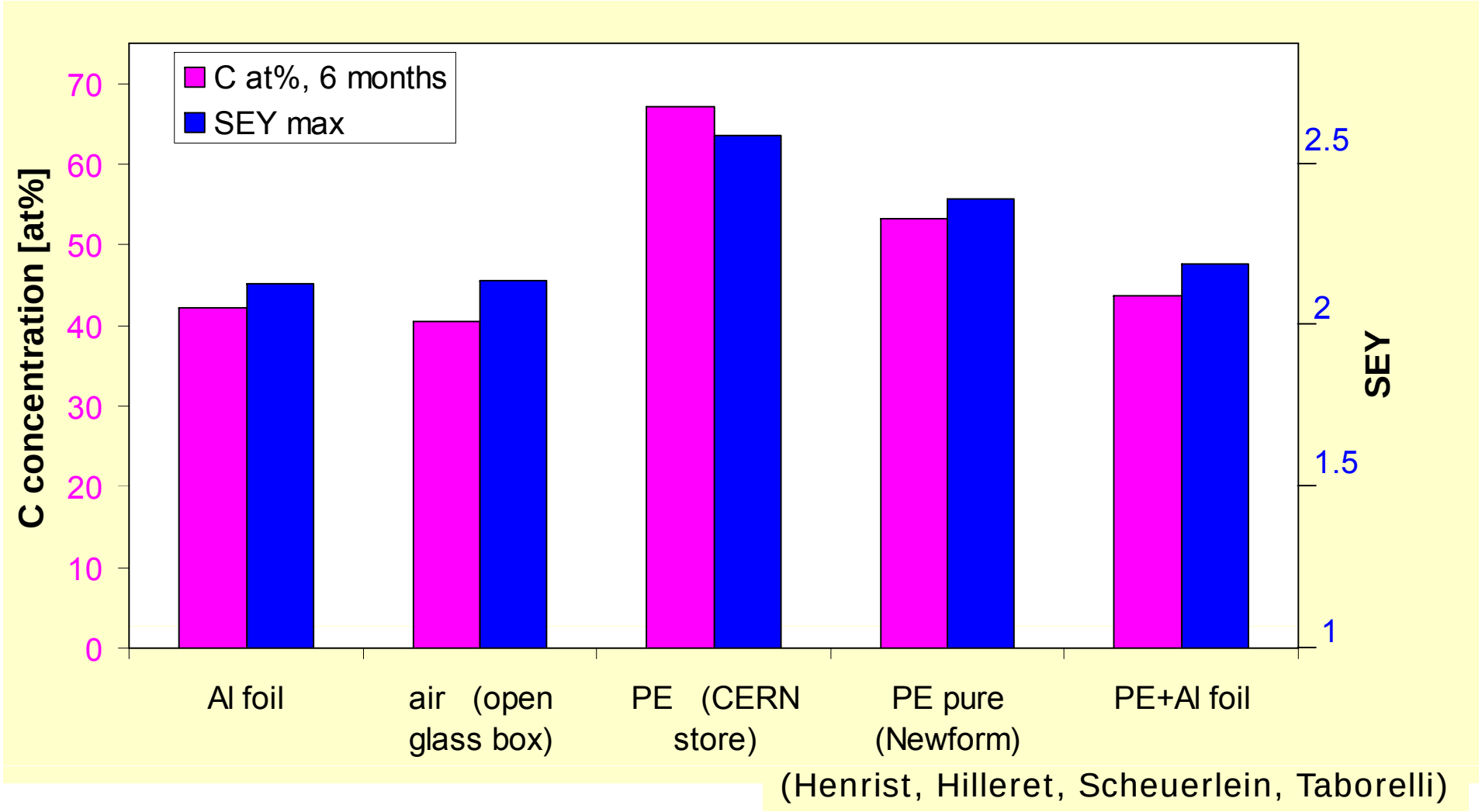


This **overlayer** of contamination is the main reason of the increase of SEY (possibly some hydroxide influence for metals): it has **high δmax**
It is present on all surfaces, since this physisorption is not material specific!
The only solution is to **reduce water/hydrocarbon exposure as much as possible**: ► again **copper** as example

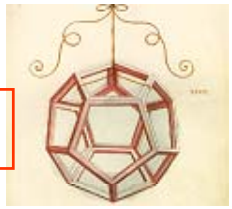
reduce water/hydrocarbon exposure as much as possible: ► effect on **copper**



Correlation between surface hydrocarbons and δmax: on copper



(Henrist, Hilleret, Scheuerlein, Taborelli)

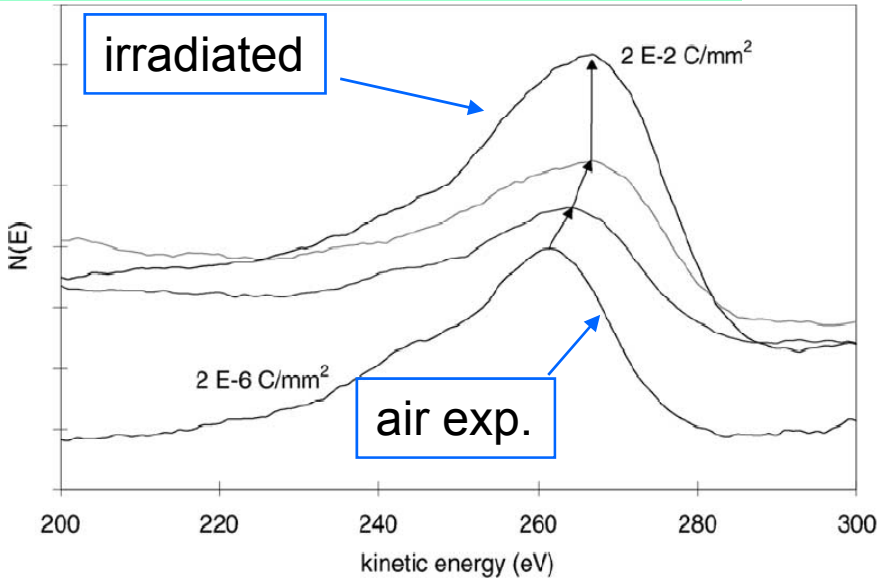


Some carbon is bad.....and some is good: conditioning

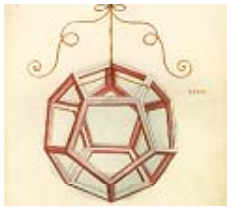
After air exposure and conditioning by e-bombardment (typically 10^{-3}C/mm^2) the **δmax of TiN decreases to 1-1.2** ; and for copper to **1.2-1.3**

Conditioning means:
-- particle stimulated desorption (H, CO..) and cleaning of the surface: is not highly material specific
--**graphitization** of the adsorbed hydrocarbons and increase of the carbon coverage

Change of CKLL Auger upon irradiation of air exp. Cu
(Scheuerlein, Taborelli, 2002, similar results in XPS by Kato 2005)



-an alternative to TiN would be a **graphite-like layer!**
(by sputtering, CVD, e-bombardment.....)



Conclusions :

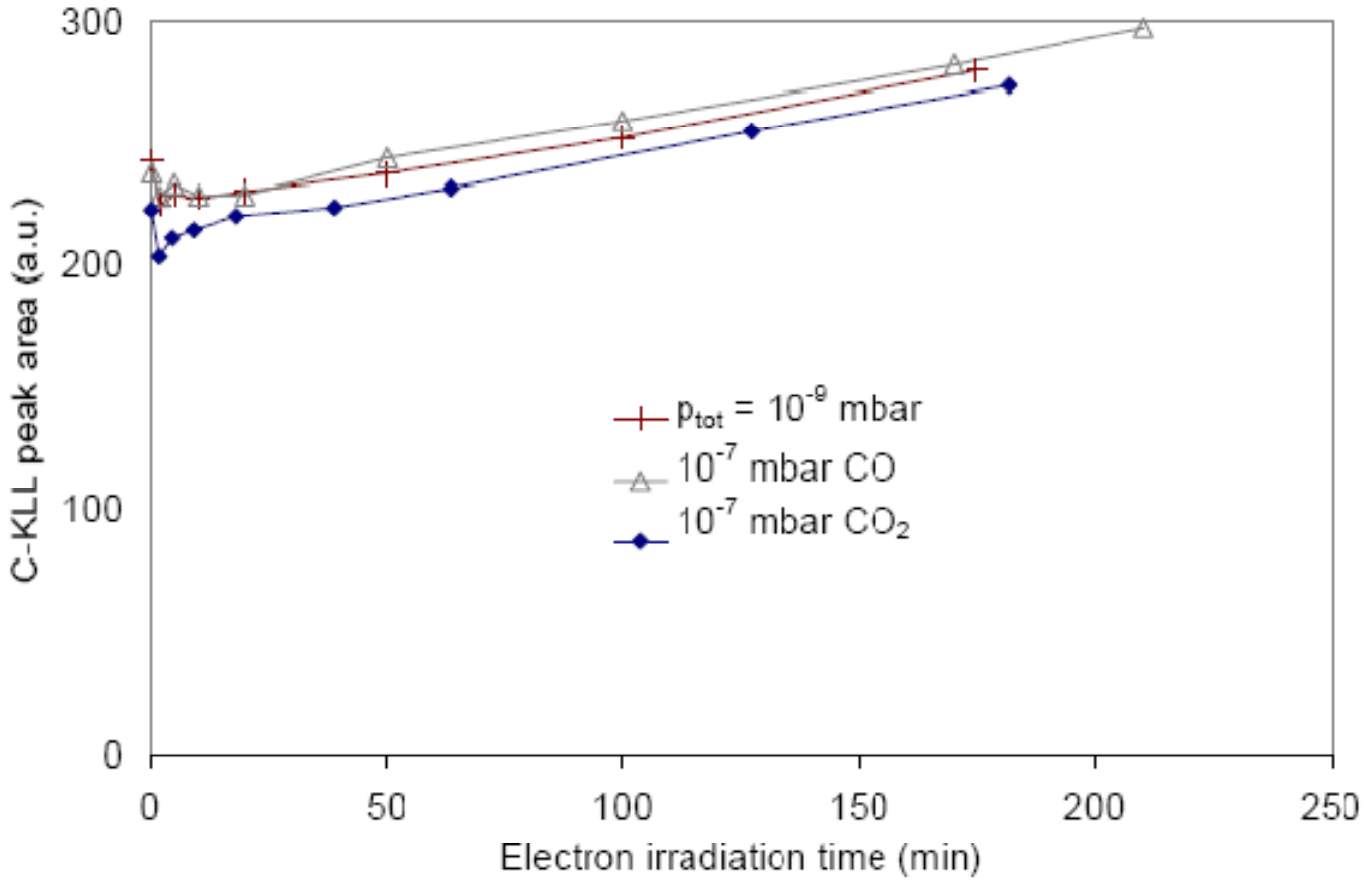
-- an infrastructure for the TiN coating of prototypes is available

--testing of liners in SPS is foreseen

--air exposed TiN is slightly better than copper if the air exposure is limited and well controlled

-- a graphite-like layer would be a valid alternative (more measurements are needed on such a system)

Acknowledgments:
C.Scheuerlein, N.Hilleret, B.Henrist


300
200
100
0
C-KLL peak area (a.u.)
0
50
100
150
200
250
Electron irradiation time (min)
p_{tot} = 10^{-9} mbar
10^{-7} mbar CO
10^{-7} mbar CO_2