UV surface cleaning by the RBD mini Z system

Type of analysis: XPS at ion beam sputtered ITO thin films

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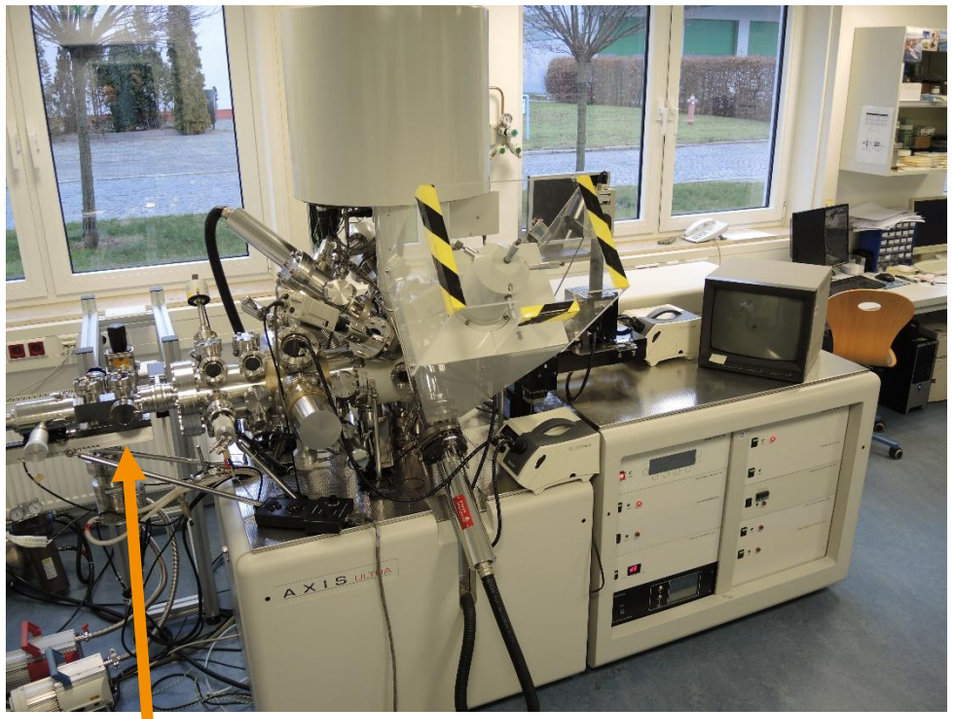
XPS measurement conditions

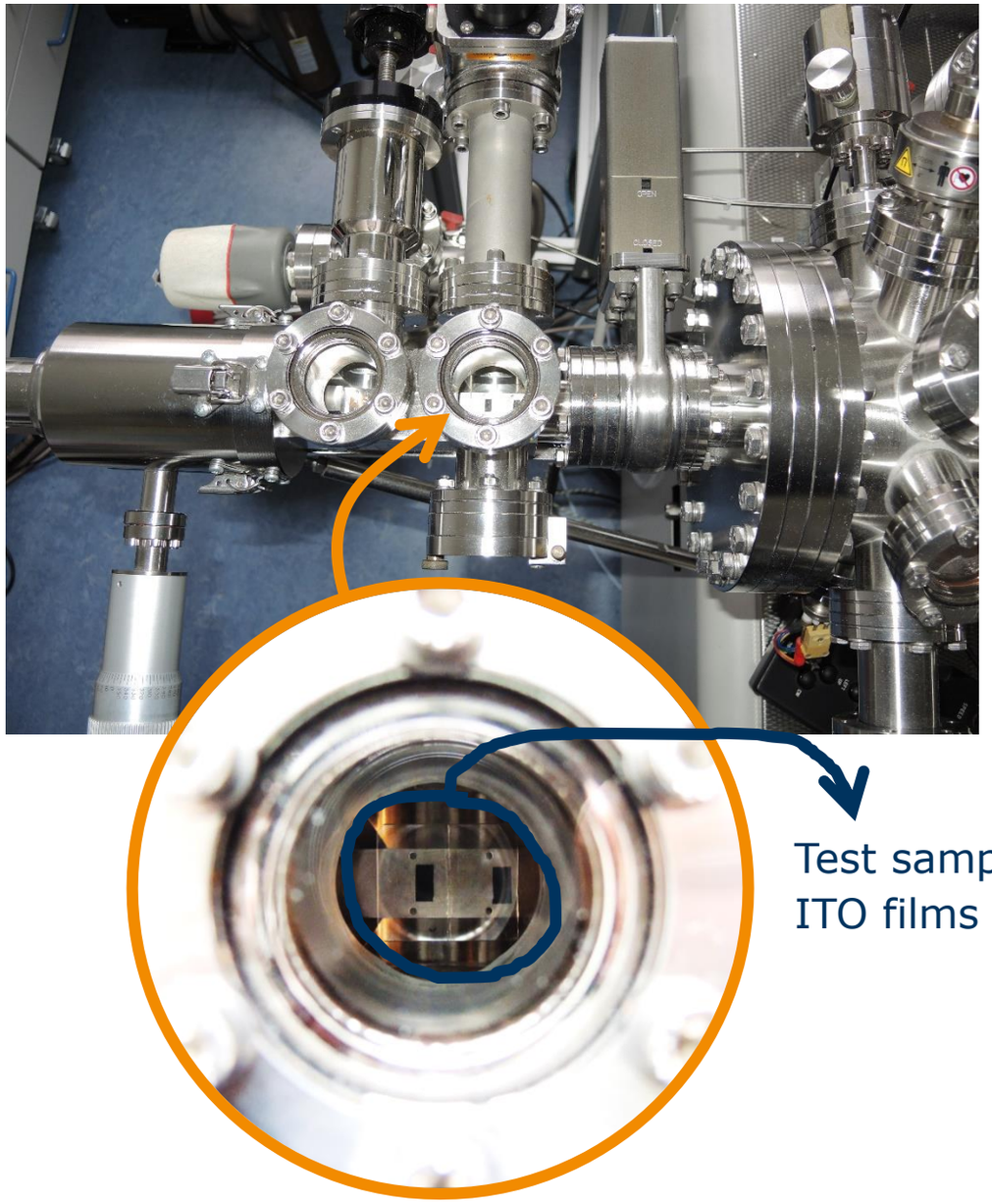


Load-lock chamber

XPS equipment: Kratos Ultra DLD

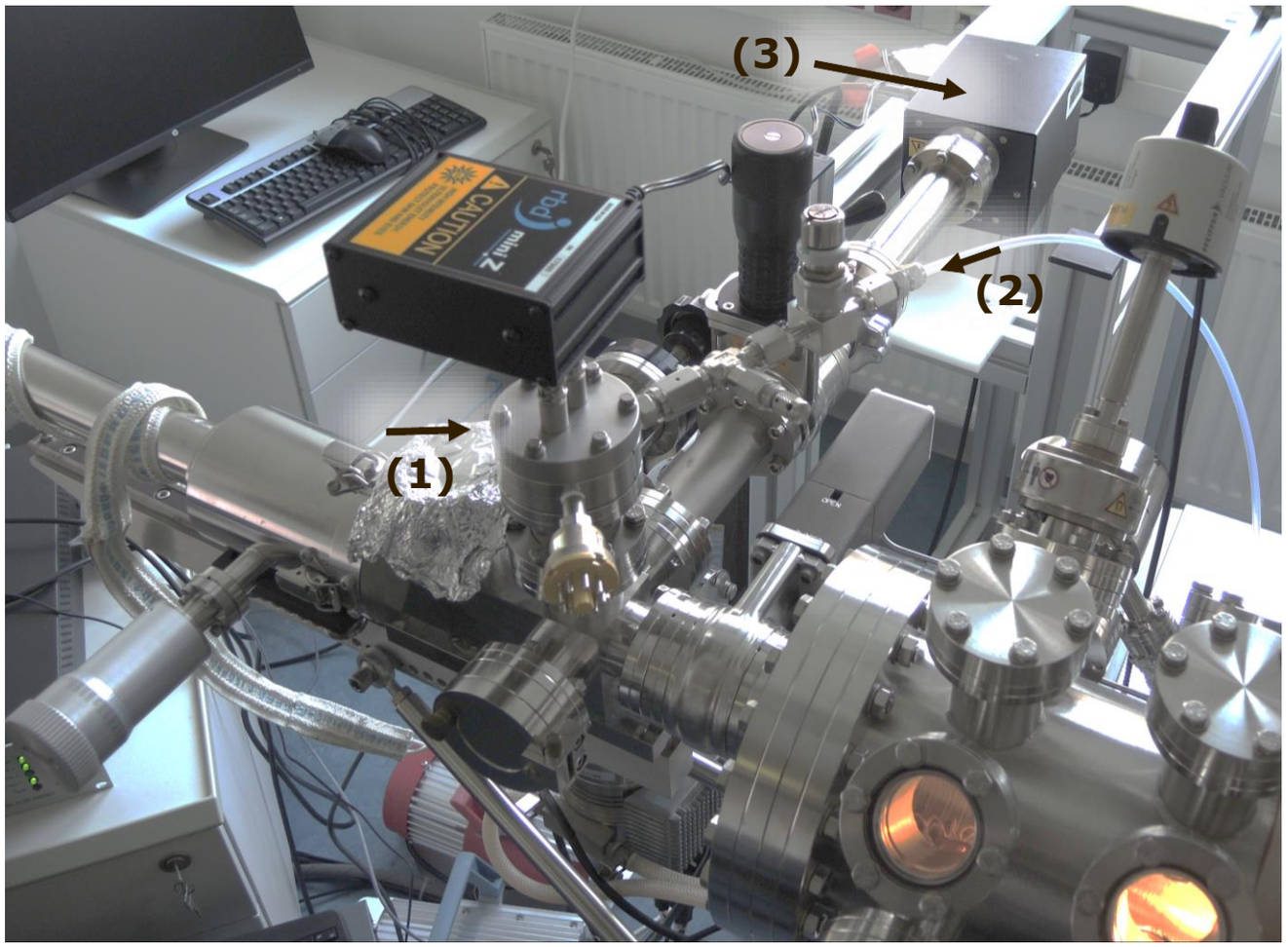
- excitation with monochromatic Al K_α-radiation (1486.6 eV)
- hemispherical analyser: measurement with 40 eV pass energy
- delay line detector
- analysis spot size: 700 x 300 µm²
- step width of the detail spectra: 0.1 eV
- spectra calibration to In 3d: E_B = 444.5 eV
- generally in XPS: no direct information about hydrogen and helium possible, only if compound peaks can be doubtless assigned

Kratos Ultra load-lock chamber



UV cleaning equipment at the load-lock chamber

HV cleaning operation

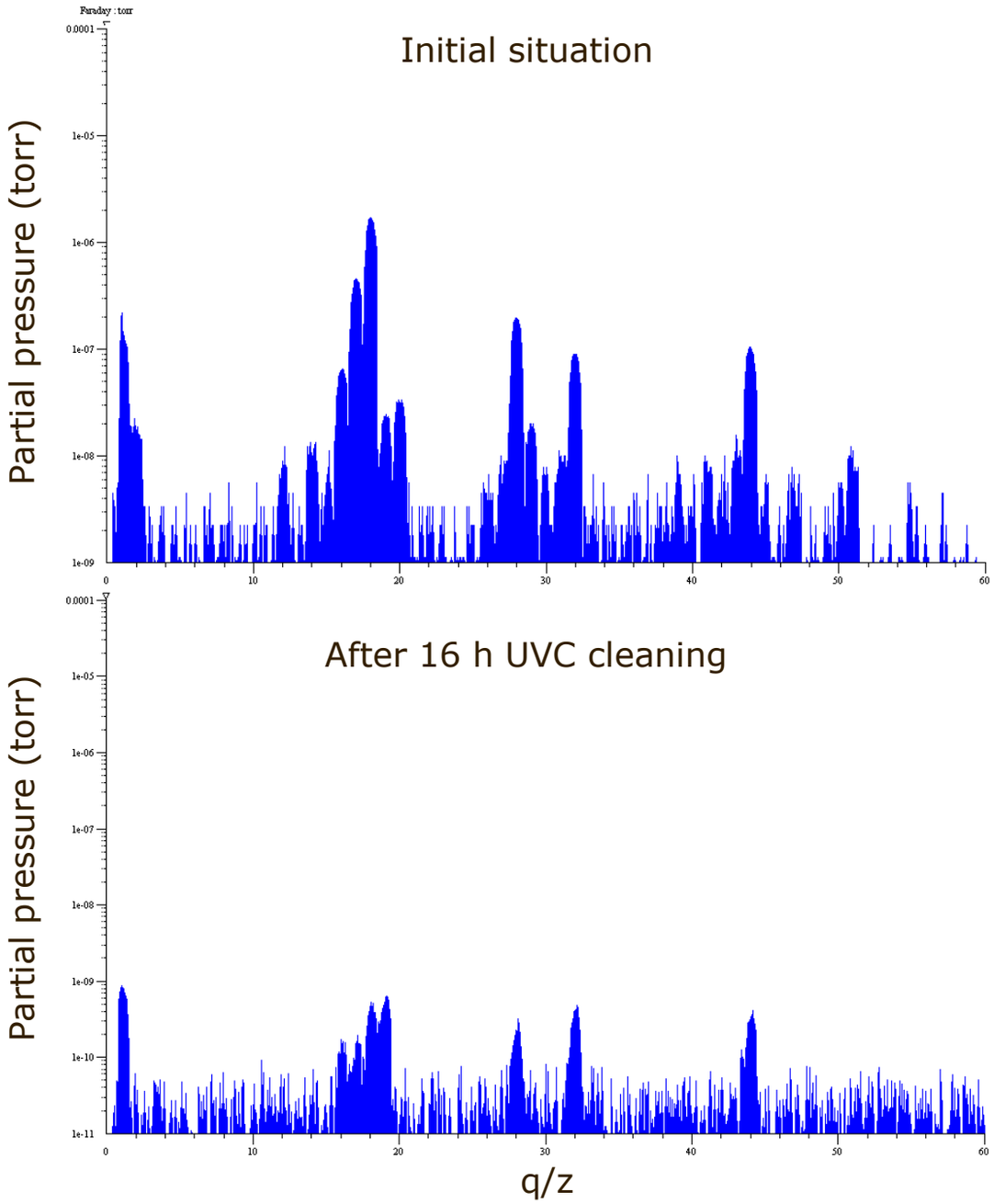


UV equipment: RBD mini Z

- 185 nm UVC radiation: 350 µW/cm^2 @ 6 cm distance
- Typical application field: water vapor desorption in vacuum systems
- O_2 background gas pressure in high vacuum range: 10^{-4} mbar

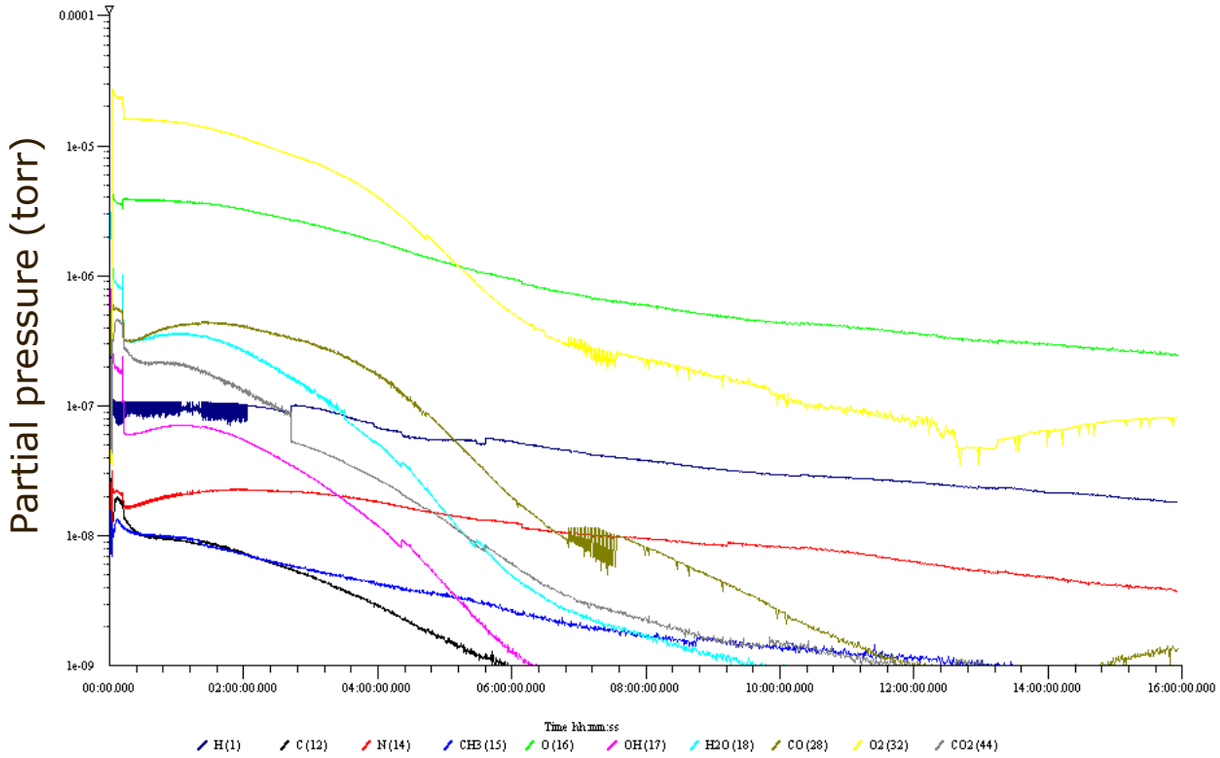
(1) miniZ system with power supply
(2) O_2 gas supply
(3) RGA system

Cleaning test at HV conditions



RGA: Hiden HAL IV RC HALO 201

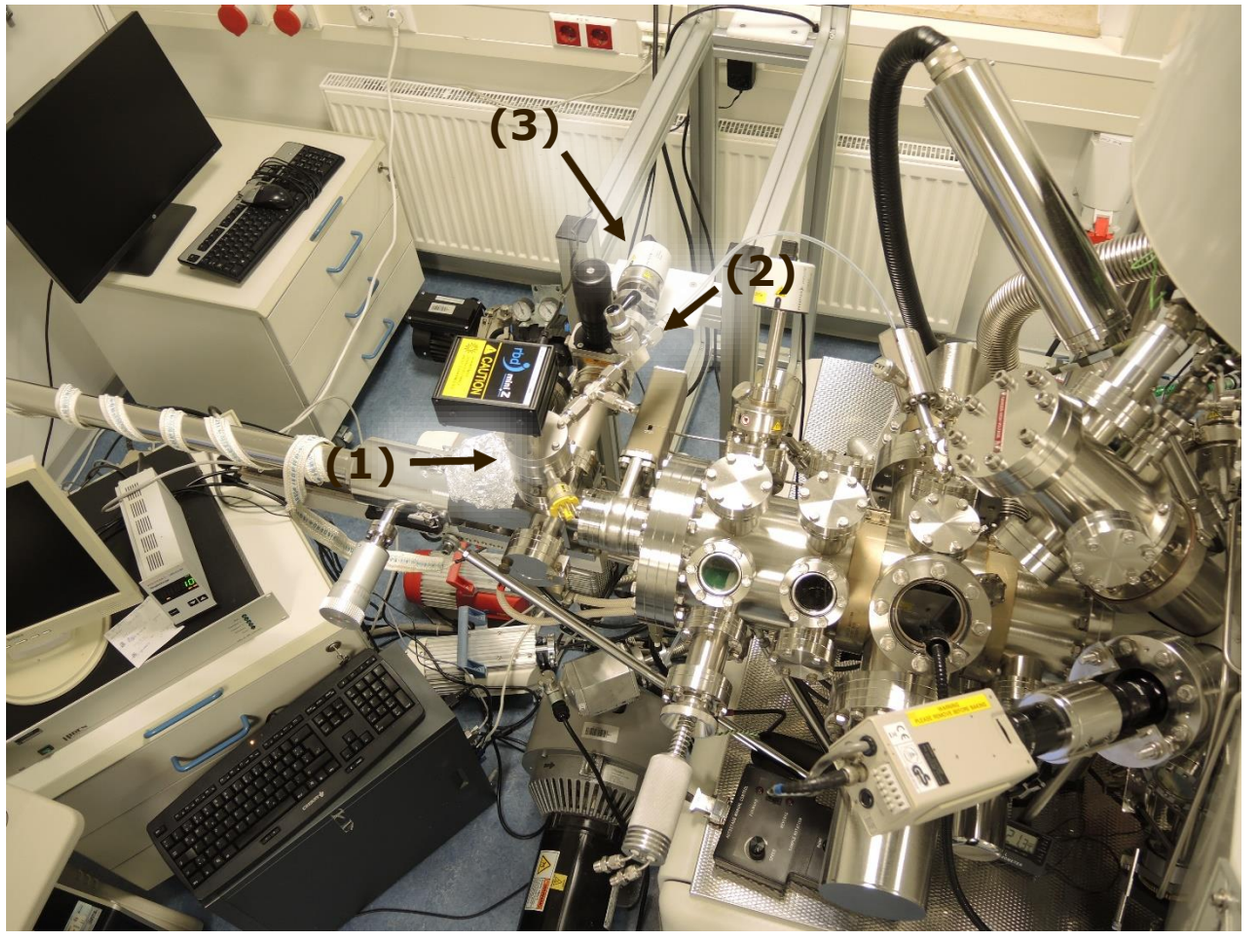
- Low pressure UVC treatment with O_2 background: p = 1 x 10^{-4} mtorr



- Continuous reduction of the partial pressures of OH, H_2O, O_2, but also C, CO, and CO_2
  → UVC treatment allows not only the water vapor desorption, but also the removal of hydrocarbons

UV cleaning equipment at the load-lock chamber

FV cleaning operation



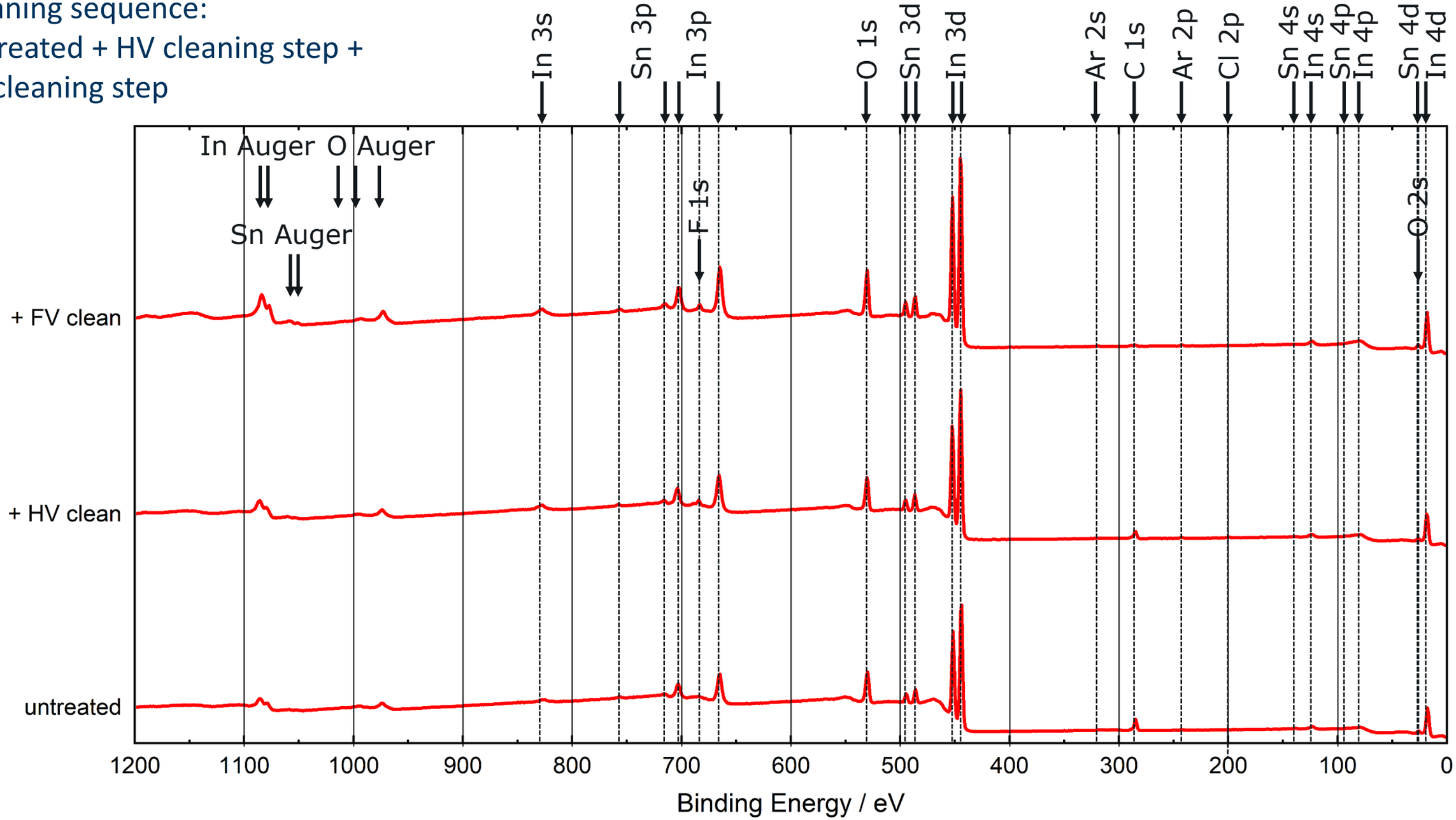
(1) miniZ system with power supply
(2) O_2 gas supply
(3) Full range pressure gauge

UV equipment: RBD mini Z

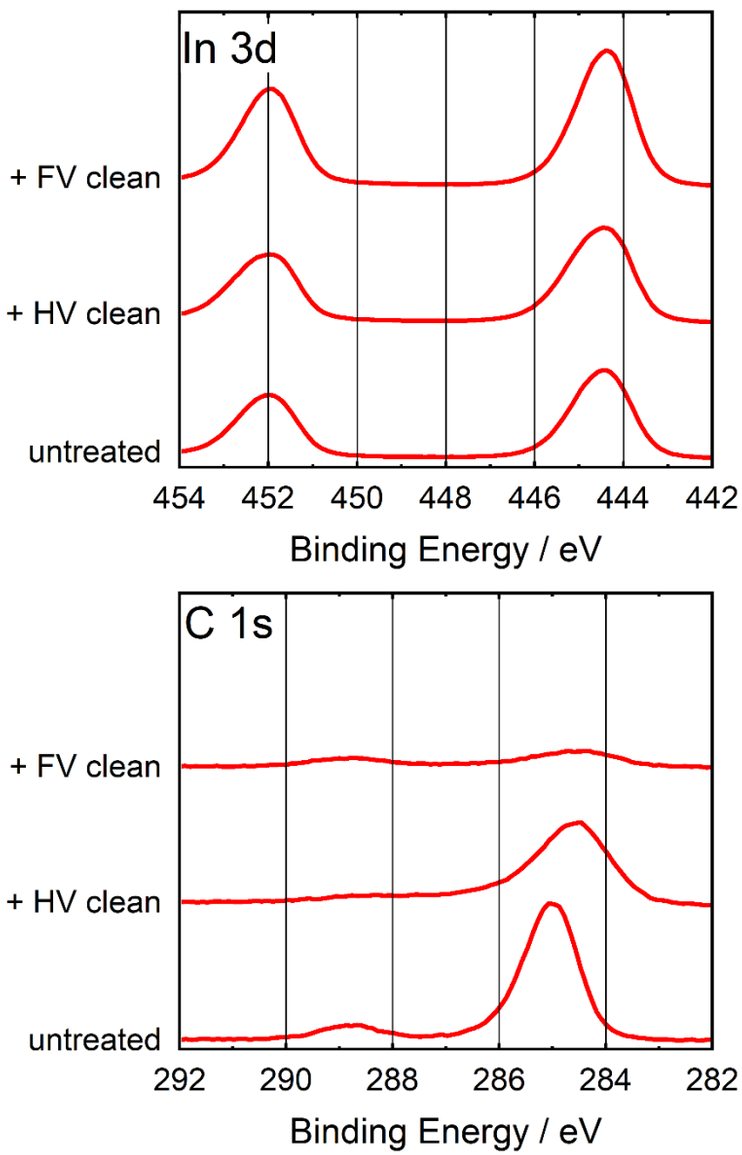
- 185 nm UVC radiation: 350 µW/cm² @ 6 cm distance
- Typical application field: water vapor desorption in vacuum systems
- O_2 background gas pressure in fine vacuum range: 10 mbar

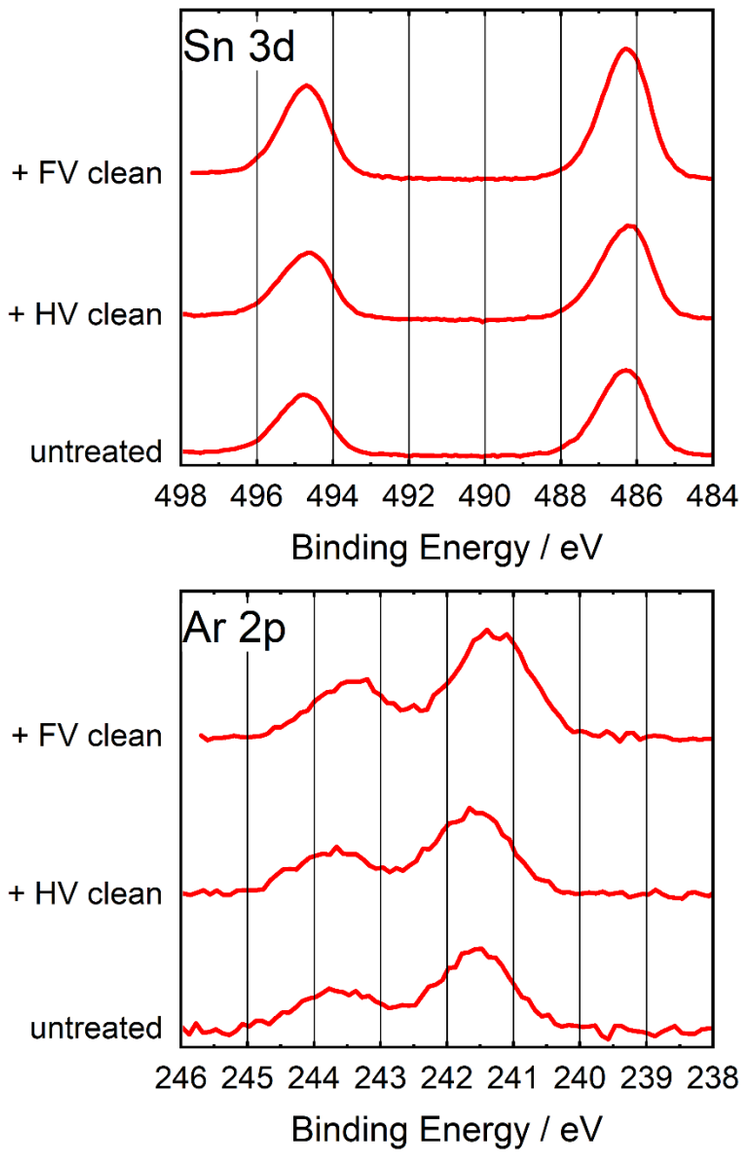
XPS - surface analysis

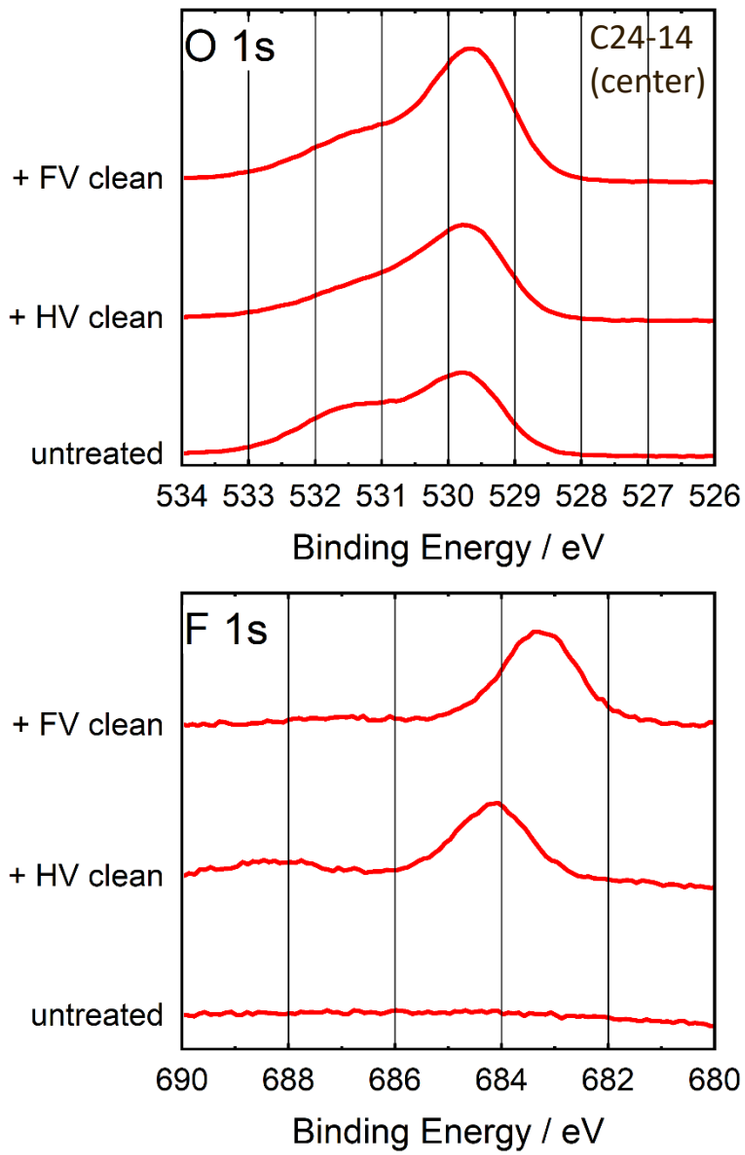
ITO sample: C24-14 / center
cleaning sequence:
untreated + HV cleaning step +
FV cleaning step



Results: XPS analysis







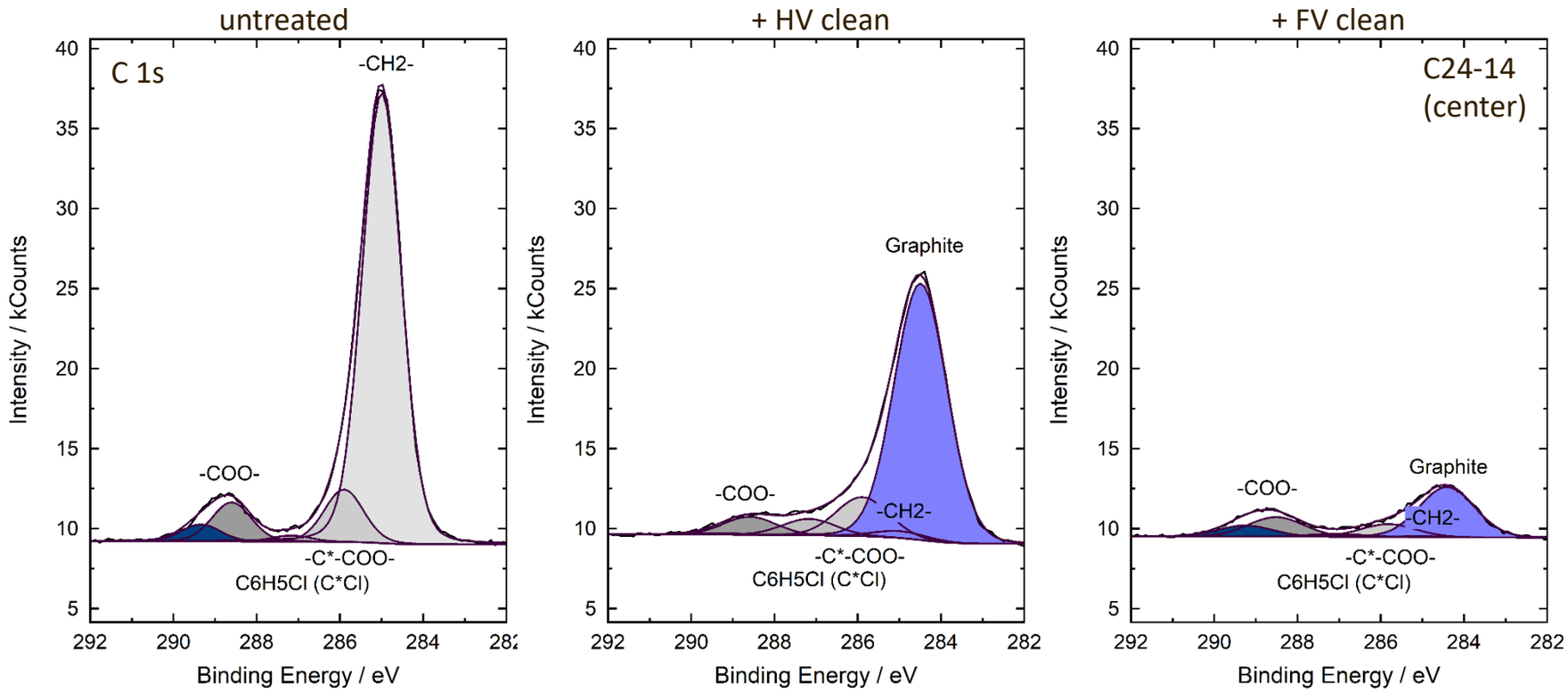
Results: XPS analysis

center at%	In	Sn	O	C	Ar	F	Cl
untreated	29.06	3.06	41.98	24.95	0.94	--	--
+ HV clean	30.52	3.29	39.10	18.71	0.79	6.84	0.75
+ FV clean	36.80	3.85	47.85	5.00	0.86	5.54	0.10

border at%	In	Sn	O	C	Ar	F	Cl
untreated	28.72	3.04	42.02	25.44	0.79	--	--
+ HV clean	30.79	3.13	39.69	18.42	0.65	6.50	0.82
+ FV clean	37.09	3.86	47.43	5.21	0.92	5.39	0.10

- high C content due to surface contaminations → strong decrease by UVC cleaning
- F & Cl fractions are related to impurities inside or on top of the ITO and appear not before cleaning
- ITO films are deposited by ion beam sputtering with process gas argon → Ar fractions

Effect of UVC cleaning – chemical analysis of C 1s



	E_B (eV)	untrea-ted	+ HV clean	+ FV clean
C-C	284.5	--	14.16	2.58
CH2	285.0	19.87	0.38	0.04
C*-COO	285.7	2.32	2.16	0.66
C*Cl	287.1	0.27	0.92	0.16
COO	289.0	2.49	1.09	1.56

- The contaminations at the untreated sample show the typical polymer structure dominating at 285.0 eV (CH2).
- The first UVC treatment step in HV leads to a destruction of the polymer revealing mainly C-C bonds as in graphite.
- The second UVC treatment step in FV results in a strong reduction the C-C peak, i.e. the main carbon amount.
- Some fractions of carbon (COO) may be part of the ITO.