SP B.4: Reference coatings for ITER and DEMO

JSI activities in 2022: XPS analysis of selected Be-D samples

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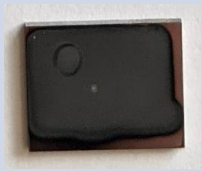
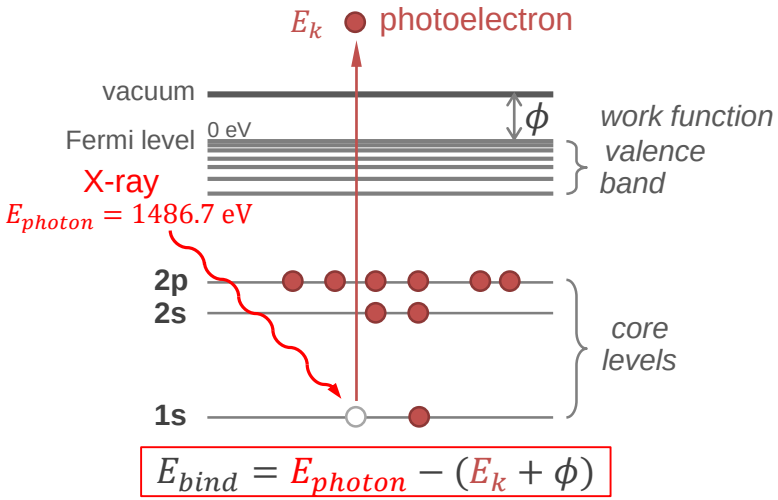
XPS analysis of selected Be-D samples

- **Task:** Demonstrate the value of XPS technique for Be-D analysis. Possibly observe nature of chemical bond between Be and D.
- **Samples:** Be-D thin films with 5% and 10% of D prepared by magnetron sputtering using different substrate temperatures

sample	60190520_2_3	60190523_2_3	60190515_2_3	60190527_2_3	60190607_2_2
thin film	Be-D	Be-D	Be-D	Be-D	Be-D
thickness	5 µm	5 µm	5 µm	5 µm	5 µm
D (at.%)	**5 %**	**5 %**	**10 %**	**10 %**	**10 %**
substrate	tungsten	tungsten	tungsten	tungsten	tungsten
sample photo					
preparation method	reactive DC magnetron sputtering	reactive DC magnetron sputtering	reactive DC magnetron sputtering	reactive DC magnetron sputtering	reactive DC magnetron sputtering
gas mixture	Ar/D	Ar/D	Ar/D	Ar/D	Ar/D
substrate temperature	**room temperature**	**400 °C**	**room temperature**	**200 °C**	**JET-like T cycle** ~60s: 60°C → 200°C ~540s: 200°C → 60°C

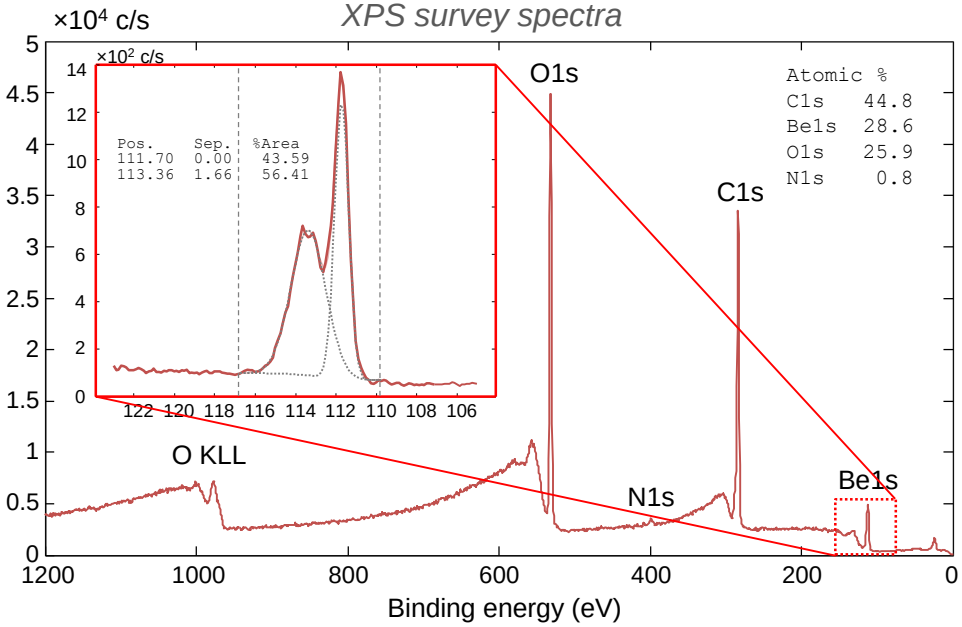
X-ray photoelectron spectroscopy

Principle of XPS measurements



$$E_{bind} = E_{photon} - (E_k + \phi)$$

XPS survey spectra

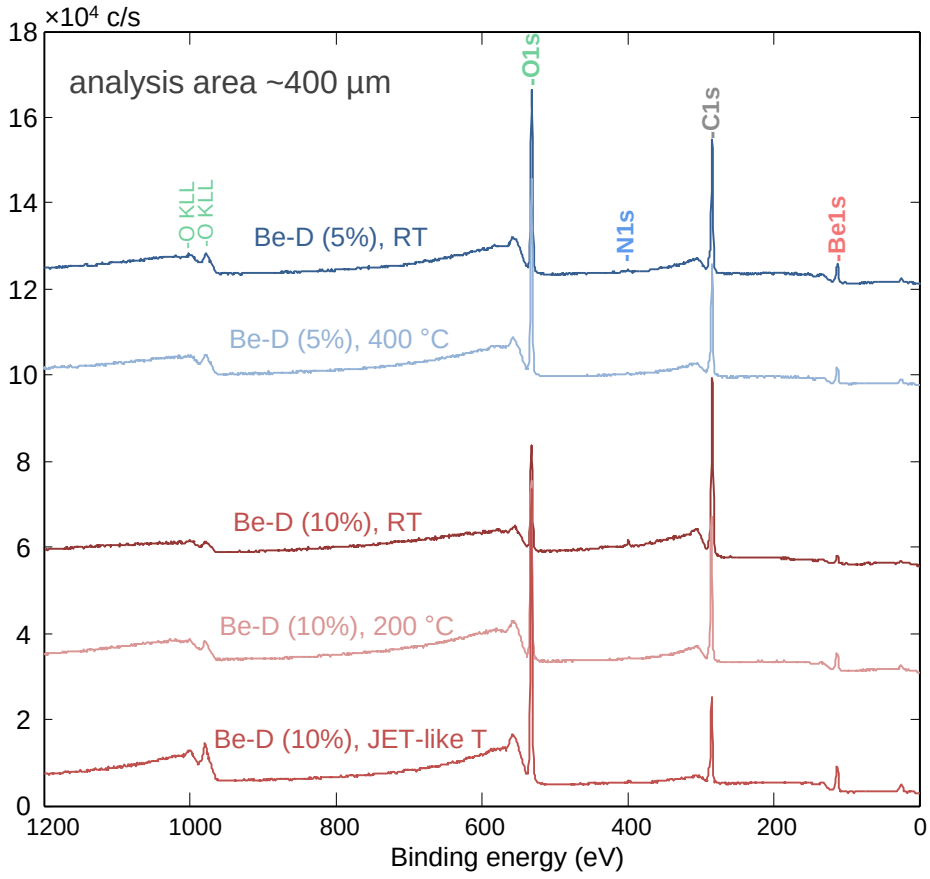


Information obtained from XPS spectra

- **identification** and **quantification** of elements (except H, D and He)
- **chemical state** of elements
- **depth profiles** when combined with ion-etching

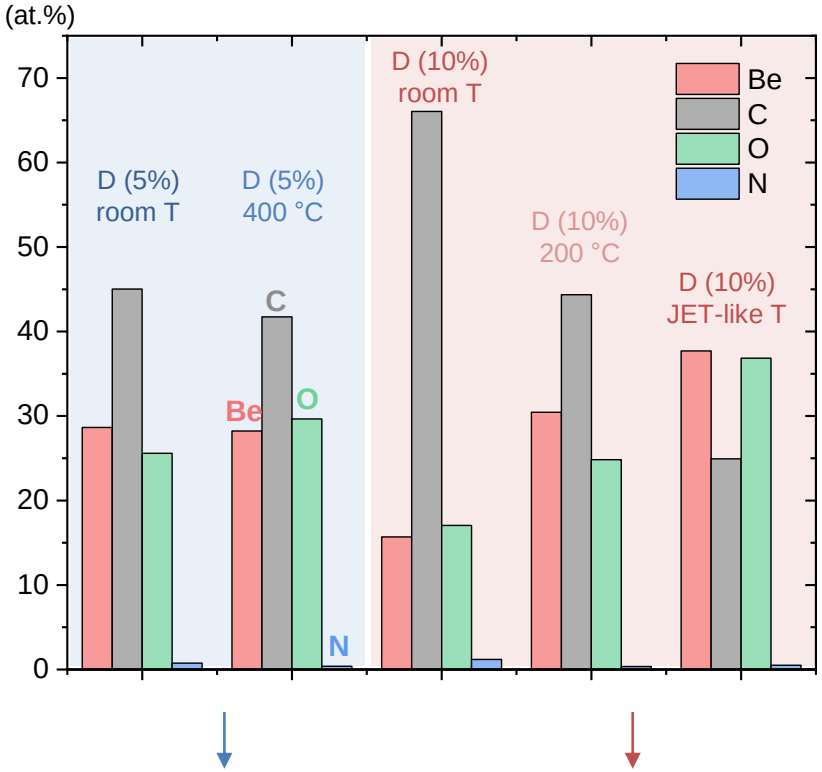
XPS surface analysis of Be-D samples

XPS survey spectra (C, O, Be, N)



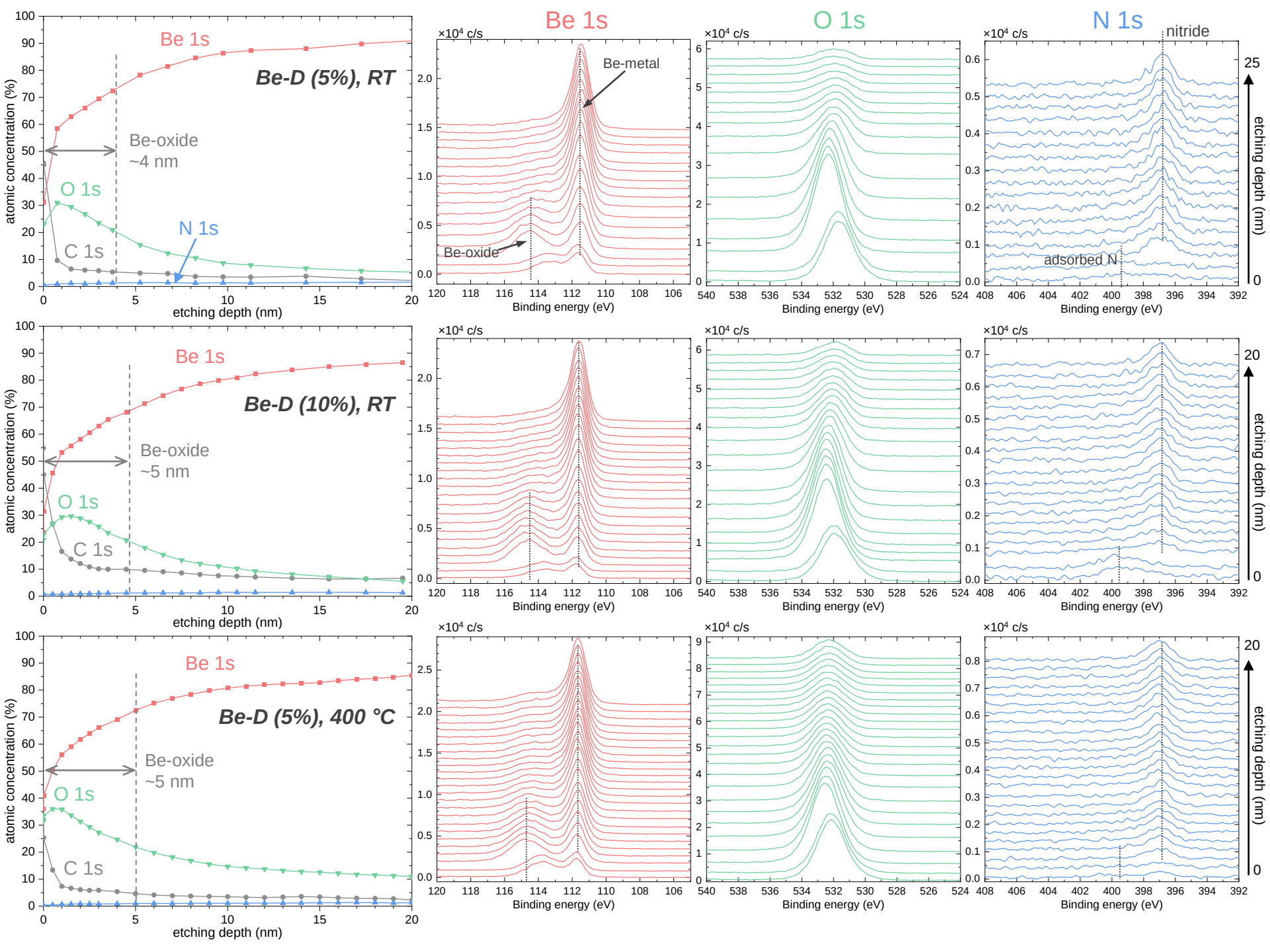
All Be-D samples show similar XPS spectra

Composition of surface

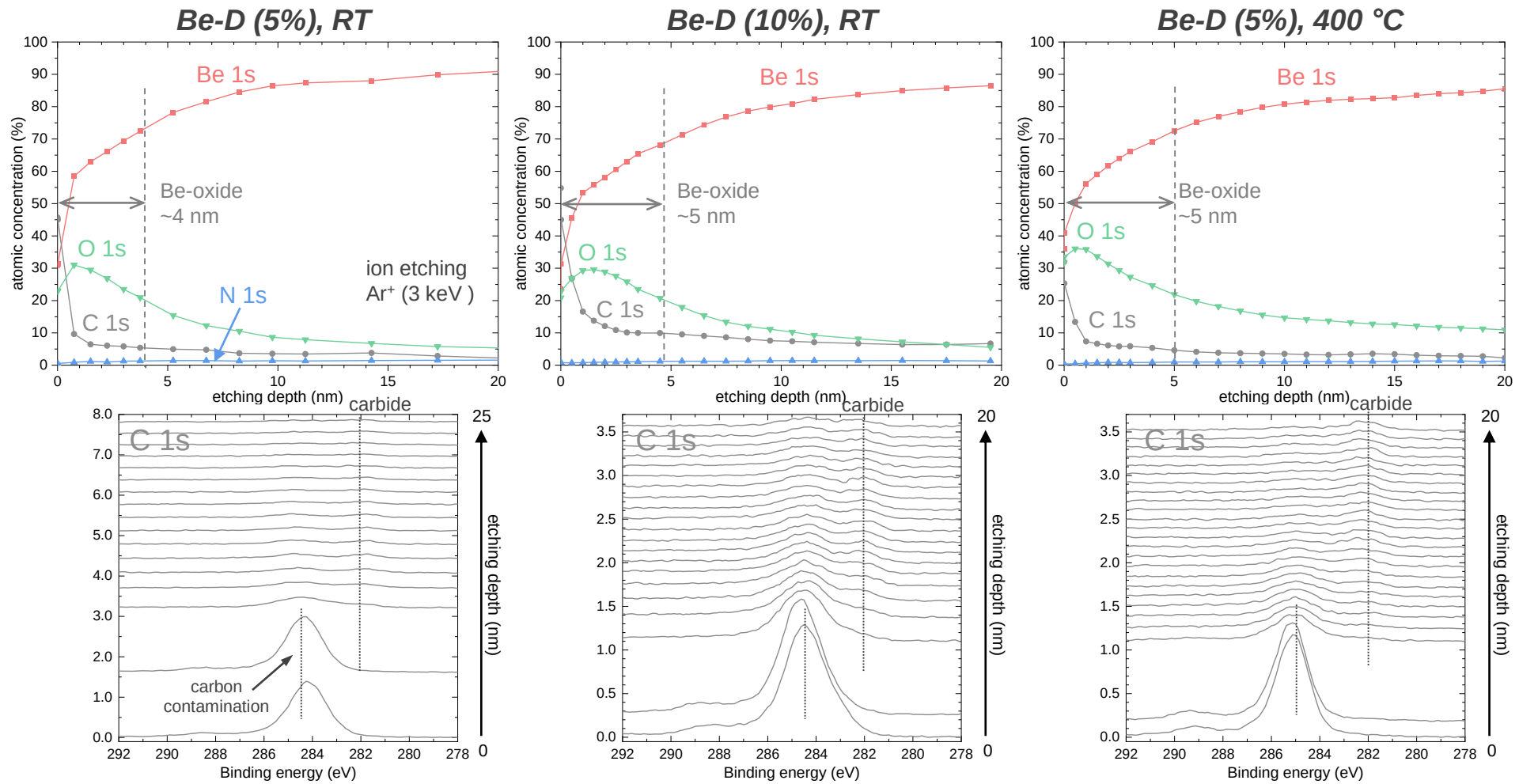


D (5%) samples
- similar composition for both samples

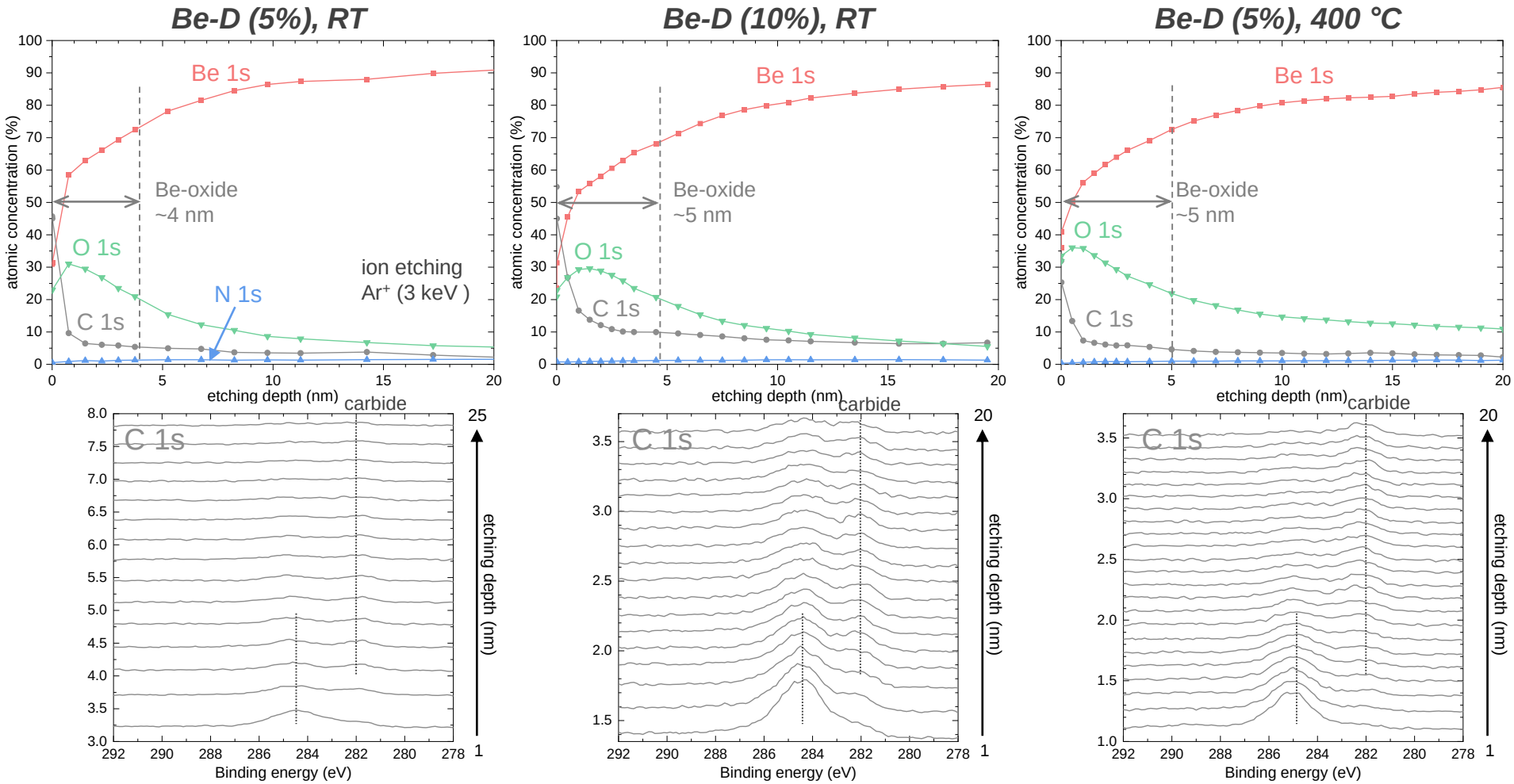
D (10%) samples
- C decreases
- Be and O increase


Be 1s
O 1s
N 1s
Be-D (5%), RT
Be-oxide
~4 nm
C 1s
atomic concentration (%)
etching depth (nm)
Be-D (10%), RT
Be-oxide
~5 nm
Be-D (5%), 400 °C
Be-oxide
~5 nm
×10⁴ c/s
Be-metal
Be-oxide
nitride
adsorbed N
Binding energy (eV)
etching depth (nm)

Depth profiles of Be-D samples



Depth profiles of Be-D samples



- **Similar depth profiles** for three analyzed samples
- **BeO** thickness ~4-5 nm. More oxygen present in sample deposited at 400 °C
- **Carbon** is present on the surface as contamination and as carbide in subsurface region (~3-6 at.%)
- **Nitrogen** is present as nitride in subsurface region (1-2 at.%)