In-Situ EXAFS Investigations of Nb-Treatments in N_2, O_2 and N_2-O_2 Mixtures at elevated Temperatures

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Motivation

- Nowadays Nb-cavities are treated in N_2-gas atmospheres at elevated temperatures to improve performance
- Many different treatments (N-Doping (880 °C), N-Infusion (150 °C), Mid-T-Bake (400 °C) etc.)

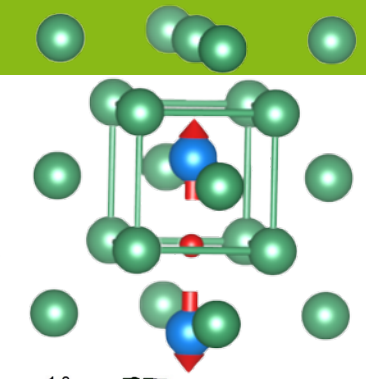
→ Cell for in-situ investigations on treatment process

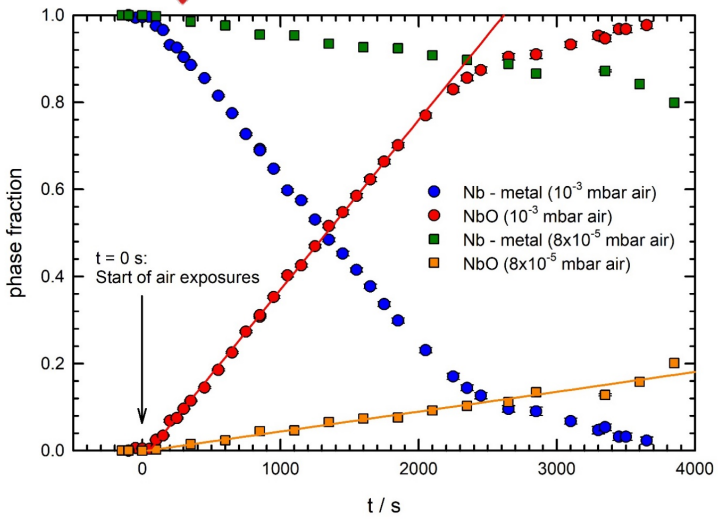
- Earlier studies:
  - Uptake of N-atom in octahedral interstitial sites is crucial
  - Nb during heating is sensitive to oxidation even at small pressures of O_2

Central Questions:

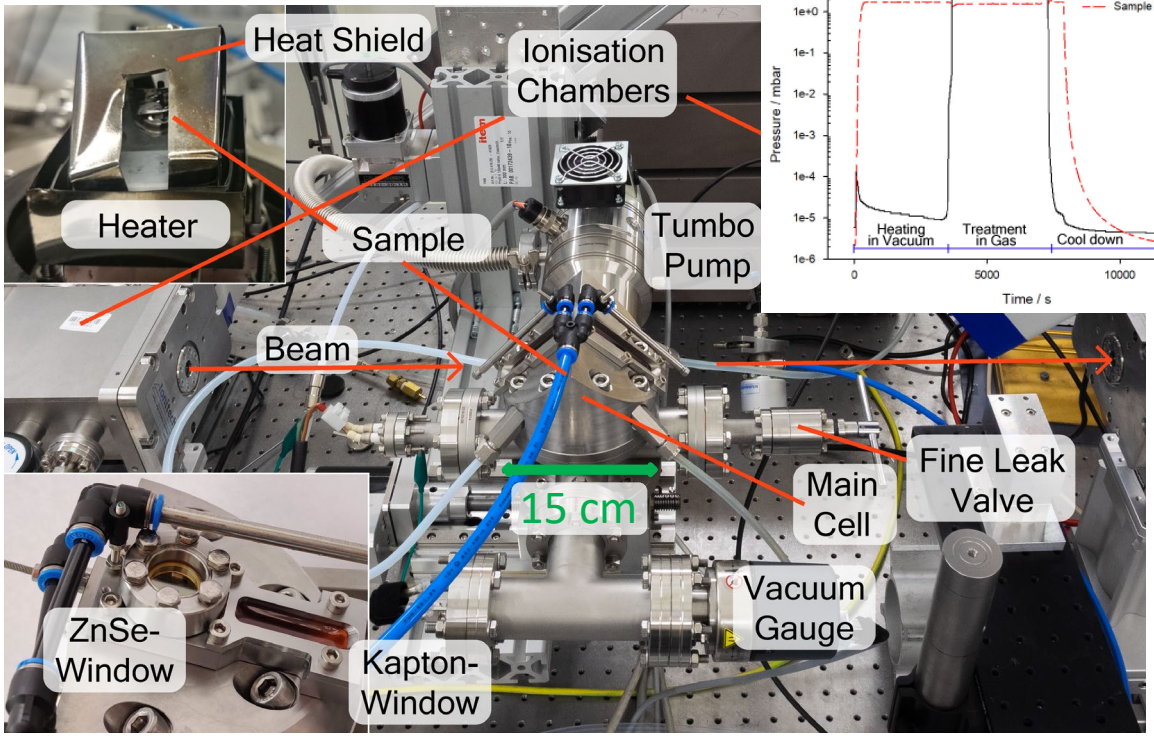
→ Is nitrogen-uptake still possible in the presence of O_2?

→ Does heating in poor vacuum supresses N-uptake?





The Vacuum Heating Cell and Treatment



- In-situ-EXAFS setup
- $T_{max} = 1200\ °C$
- $p_{min} < 10^{-6}$ mbar
- ZnSe-window for IR-T-measurement
- Fine leak + magnetic valves for gas treatments
- Water and air cooling

Standard - treatment:

- 1h at 900 °C in vacuum
- Treatment in gas
- Cool down in vacuum

Heating in bad vaccum and N_2 treatment afterwards

Raw absorption spectra:

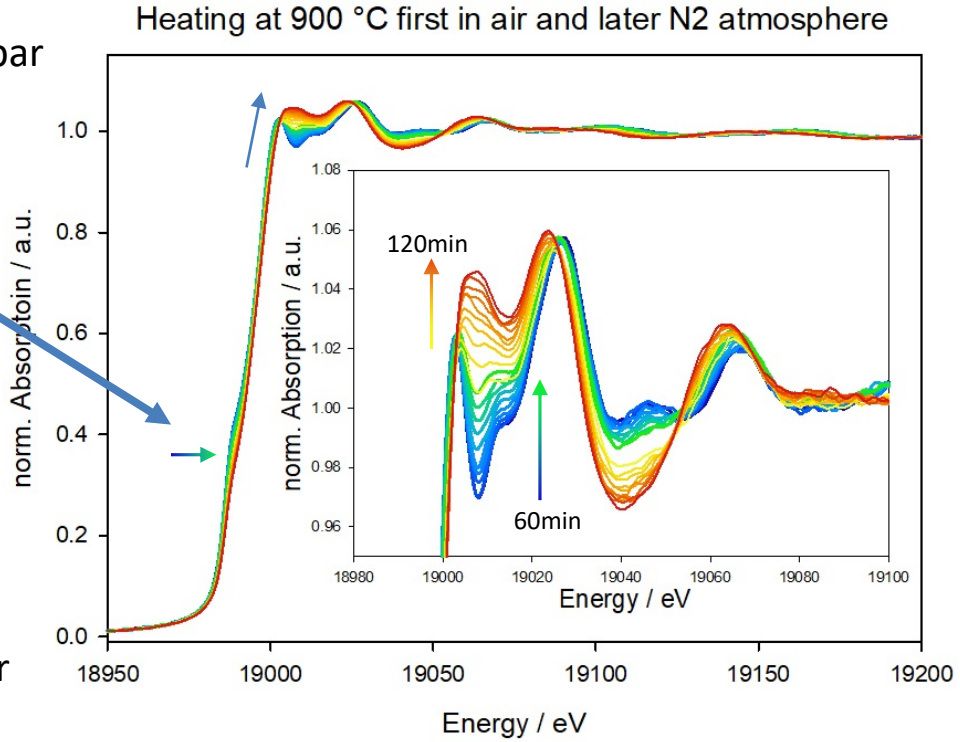
- Blue → green: bad vacuum @ 900 °C, $2x10^{-4}$ mbar
- Yellow → red: N_2 treatment @ 900 °C, 3 mbar

Poor vacuum conditions:

- Slight shift in edge energy to higher energy
  → Indiction for Nb - oxidation
- Isosbestic points → two phases only

N_2 treatment:

- No additional oxidation
- XANES development continuous
- Isosbestic points smear out
  → Nb unit cells partly occupied with O- and/or N-atoms on octahedreal interstitial sites



Treatment in N_2-atmosphere of bad purity (1000:1 N_2-O_2)

Treatment: 900 °C @ 3 mbar in N_2-air mixture (1000:1)

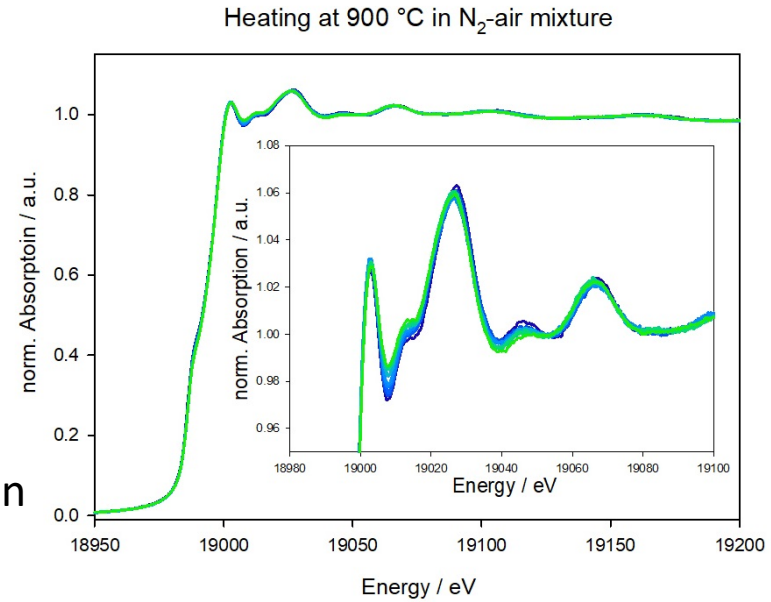
- No Edge shift

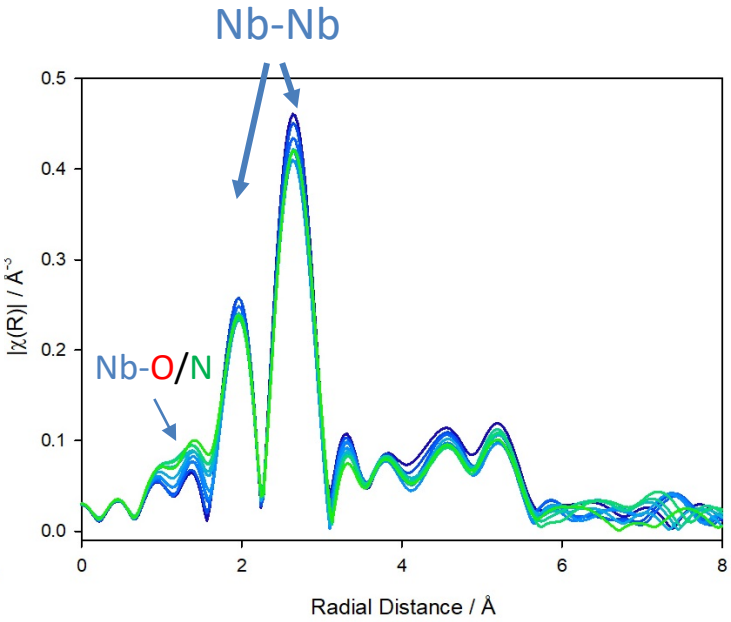
→ Less oxidation

- No isosbestic points

  → propably three phases

→ Multi phase fit necessary for further information





Conclusions

- Heat treatments of Nb: Effect of oxygen on the short range structure of Nb similar to N
- O and N „compete“ on interstitial octahedreal sites in the Nb unit cells

  → O has an effect on N-doping treatments!

  → Influence on mid-T-bake and/or N-infusion as well?

  → Effect of oxygen on Nb cavity performance (Q-factor, RF-superconductivity) has to be investigated!

- Fits of the first two shells and multi phase fits have to be done for mode detailed information on the effect

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Thank you
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