

Introduction

Gaseous inclusions in ice cores are essential for reconstruction of the palaeoatmosphere. However, the processes governing fractionation and diffusion during e.g. pore closeoff or bubble-clathrate transition are not fully understood yet.

- → Does gas content change during pore closeoff?
- → Does gas content change during bubble-clathrate transition?
- → Are gas mixing ratios influenced by fractionation or diffusion?
- → Are there systematic differences between clear bands and cloudy bands?

Raman spectroscopy

Confocal micro Raman spectroscopy allows for highresolution mapping of gas mixing ratios inside individual inclusions.

 N_2/O_2 ratios can be used as proxy for the evolution of trace gasses (CO_2 , CH_4 , $N_2O...$).

Information can be gained about fractionation and diffusion parameters.

 \rightarrow high resolution, high reproducability, non-destructive



Peaks of the N_2/O_2 - stretching as well as the OH-stretching and lattice vibrations of the ice matrix are indicated.





Raman spectroscopy of bubbles and microbubbles in EDML antarctic ice core

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Examples of the possibilities of high-resolution gas measurements by Raman spectroscopy |a|: Several types of gaseous inclusions with corresponding N₂/O₂-ratios | *b* |: Secondary clathrates, mechanically disrupted



The different types of gaseous inclusions can be identified by characteristic changes of the Raman shift compared to the air signal.

Microfocus X-ray computer tomography enables the detection and analysis of all bubbles and microbubbles inside large volumes of ice.

For more details on this technique see also Poster XL204 (EGU2011-3390).





This example shows the N₂-stretching.

Computer Tomography



| *a* |: Line scanner image

| b |: Bubble distribution reconstructed from CT scans



Open Questions

- \rightarrow Which processes lead to the microbubbles' enrichment in O_2 ? (diffusion during storage and relaxation?)
- \rightarrow Do the same processes act in every depth?
- \rightarrow Plate-like inclusions (PLIs) contain only O₂. Is their generation linked to microbubbles?
- \rightarrow Can microbubbles be described as secondary relaxation features?
- \rightarrow Does fractionation between bubbles and clathrates influence the measured gas contents?