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Location and composition of micro-inclusions in deep ice from the EDML ice core (Antarctica) using optical microscope and cryo-Raman spectroscopy.

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The impurity content in meteoric ice from polar regions is relatively low compared to other natural materials. However, it controls a variety of physical properties of ice - from dielectric response to its mechanical behaviour. Links between impurity concentration, changes in ice micro-structure and deformation rate have been reported on several scales. In order to approach the responsible mechanisms, a better understanding is needed regarding the in-situ form, location, and distribution of the different species within the polycrystal. We used an optical microscope to generate high-resolution 2D-maps of micro-inclusions in deep ice from the EDML ice core (Antarctica). Superposition of the grain boundary network and micro-inclusion distributions shows no significant correlations between grain boundaries and micro-inclusions. Implications for the relevance of Zener pinning during grain boundary migration and redistribution of impurities by grain boundary drag are discussed. Raman spectra of micro-inclusions in selected regions were obtained using a confocal cryo-Raman system. Comparison with ion chromatography shows that most of the available ions in ice precipitate in form of micro-inclusions. However, indications were found that some of the residual components could coexist in form of solid solution.

Significance statement

Ice cores serve as archives of atmospheric aerosols from the past. Furthermore, these impurities control physical properties of ice in polar ice sheets. A better understanding of impurity-related processes on micro- and nano-scale is needed to properly model ice flow.

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