Impurity migration and diffusion during deformation-induced recrystallization of ice

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Impurities enclosed in polar ice cores provide, in both solid and dissolved forms, important proxies for the reconstruction of past climates and environments. Various types of investigations have been conducted on the composition, origin, modes of formation and diffusion properties of impurities found in ice cores. However, little is known on the effect of recrystallization, which is active from the firn zone to the bottom zone of ice sheets, on the migration and diffusion of impurities in ice. The present study focuses on these impurity relocation processes resulting from recrystallization in ice. Deformation and annealing experiments were carried out at -5 ˚C using artificial pure ice samples and artificial ice samples enriched in either soluble or solid impurities (e.g. H_2SO_4, HCl or SiO_2 beads). A specific mold allowing ice samples to be deformed at a constant strain/extrusion rate ($3.1*10^{-6}$ s^{-1}) was used for our deformation experiments. An ECM (Electrical Conductivity Measurement) instrument was also designed and used for measuring concentration variations of soluble impurities in the deformed/annealed ice samples. Finally, solid particle distribution and c-axis orientation were investigated through optical microscopy and etch-pit methods respectively. The effects of deformation and annealing on impurity migration are discussed in the light of our results.