Individual ice crystals possess a strong plastic anisotropy. In ice sheets and shelves this results in the development of flow-induced patterns of preferred crystallographic c-axis orientations and polycrystalline anisotropy. The deformation rates of anisotropic polycrystalline ice can be enhanced by up to an order of magnitude over rates encountered in isotropic polycrystalline ice, where c-axes are randomly oriented.

We conducted laboratory deformation experiments on fine-grained polycrystalline ice at -2°C. Samples were initially-isotropic, laboratory-made material and initially-anisotropic material obtained from the DSS (Dome Summit South) ice core, Law Dome, East Antarctica. Experiments were conducted in both unconfined uniaxial compression and horizontal simple shear at octahedral shear stresses of 0.1-0.8 MPa, and were continued to strains exceeding 10%, allowing measurement of steady-state tertiary creep rates and observation of crystal orientation fabrics compatible with the stress configurations.

Previous studies indicate a creep power-law stress exponent of $n=3$ for minimum strain rates of isotropic polycrystalline ice. Our experimental data further verifies this observation. For the tertiary creep of anisotropic ice in uniaxial compression or horizontal simple shear our results indicate a stress exponent of $n=3.5$. Dynamic steady-state tertiary creep, where crystal orientation fabrics are compatible with the stress configuration and flow history, is the deformation mode relevant to polar ice masses, and our results suggest an effective creep power-law stress exponent of $n=3.5$ is appropriate there. The extent to which tertiary deformation rates are enhanced by the development of polycrystalline anisotropy also depends on the stress configuration.