In this presentation we describe techniques developed to characterize the microstructures found in polar ice sheets. These include: scanning electron microscopy (SEM) coupled with energy dispersive X-ray spectroscopy (EDS) and electron backscatter patterns (EBSPs); confocal scanning optical microscopy (CSOM) coupled with Raman spectroscopy; and micro X-ray computed tomography (micro CT). The capabilities and limitations of each technique are discussed.

An FEI XL-30 field emission gun SEM equipped with a Gatan cold stage and cryotransfer system is used to examine both ice and firn specimens. By acquiring both EDS and EBSP data along with secondary electron images it is possible to document the microstructural location of impurities and crystallographic orientation of grains in ice. Dust particles can also be identified using a combination of EDS and EBSP. While the SEM/EDS provides information on the elements present, it does not work well for light elements and provides no information on chemical groups. Thus, CSOM coupled with Raman spectroscopy is used to determine the compounds present in grain boundaries and triple junctions at a similar spatial resolution (1 mm) to EDS.

A Skyscan 1172 micro CT located in a -14°C cold room is used for non-destructive characterization of the internal structure of firn. Data available from the 3-D reconstructions include values for porosity, pore anisotropy, surface area-to-volume ratio and some topological variables. Since the technique is nondestructive, specimens can be sectioned and examined in the SEM afterwards in order to determine the grain size, grain orientations and the impurities present.