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Electron Microscopy for Morphological Analysis of Black Carbon Accumulated in Glaciers

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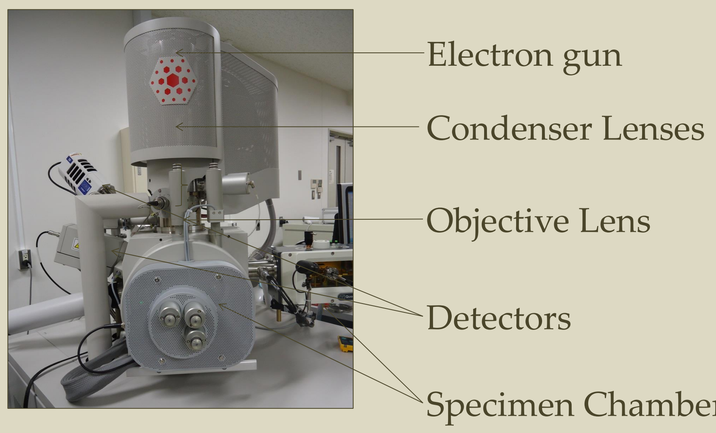
Research Area

Since the mid-20th century the decrease in anthropogenic emission of Black Carbon in Europe and North America has been recorded as a decreased Black Carbon accumulation in Greenland. However, the present-day concentrations of Black Carbon in Greenland are higher compared to the Black Carbon concentrations from the pre-industrial time, and the Black Carbon concertation in the Arctic.

Accumulation of Black Carbon in the glaciers correlates with a decrease in the surface albedo and therefore Black Carbon is thought to be one of the causes that lead to the melting of the glaciers. The morphology of Black Carbon depends on its origin, the various processes during transportation and the incorporation process into snow.

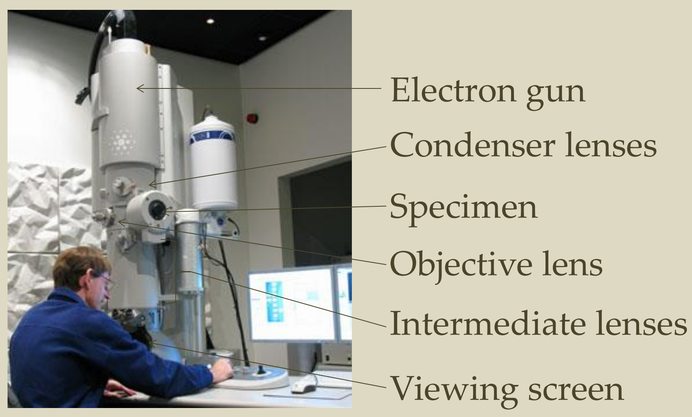
In the present study we evaluate the use of electron microscopy for morphological analysis of Black Carbon. We use both scanning electron microscopy (SEM) and transmission electron microscopy (TEM) for the analysis of Black Carbon in snow collected from Greenland and Alaska.

FEI Quanta FEG 450 (Scanning Electron Microscope- SEM)



In the high vacuum SEM a finely focused beam of electrons is moved across the specimen one point at the time. The electrons interact with the sample and causes electron emission, which is collected and amplified by an electron detector (Everhart Thornley). The image is assembled –like a mosaic – from the pixels sequentially examined by the beam and displayed on a computer screen.

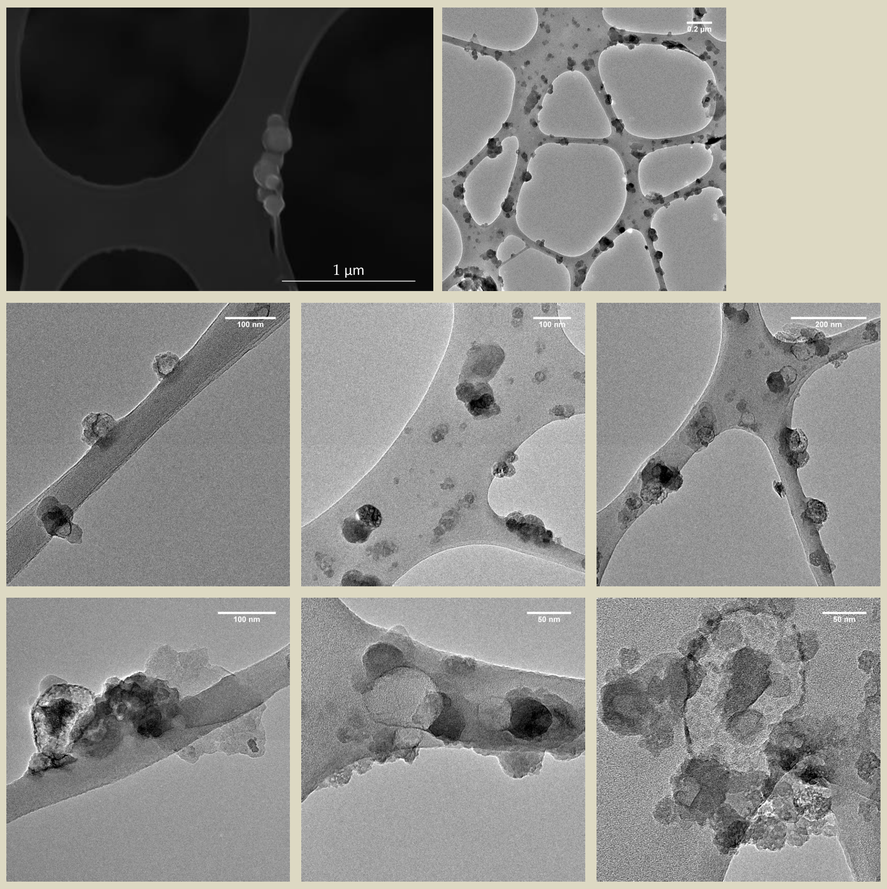
FEI Tecnai T20 G2 (Transmission Electron Microscope-TEM)



In the bright-field TEM the sample is exposed to a parallel beam of accelerated electrons. The electrons interact with the sample and the transmitted electrons containing structural information are projected onto a vieviwing fluorescent screen. The image is recorded with a CCD camera and displayed on a computer screen.

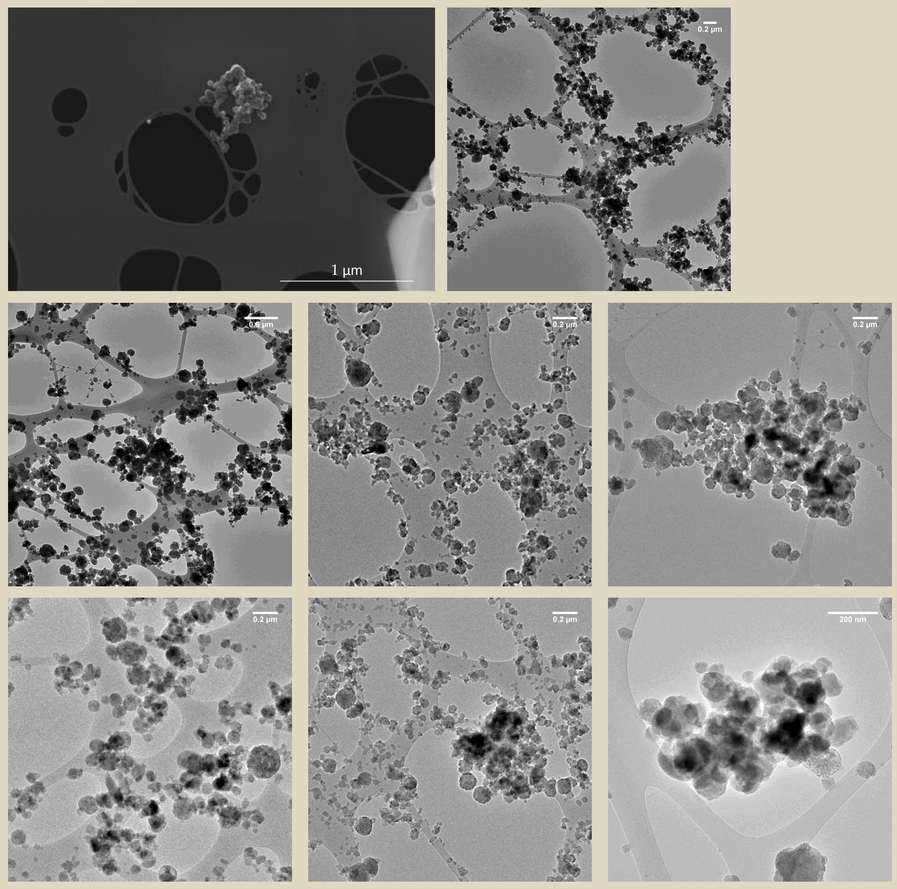
Results

Black Carbon in Snow collected from Greenland



The Black Carbon particles accumulated in Greenland's snow have fewer monomers with a pearl on a thread (chain like) preferential arrangement.

Black Carbon in Snow collected from Alaska



The Black Carbon particles accumulated in Alaska's snow have a large number of monomers with a compact preferential arrangement.

Conclusions and Future Work

We show that there is a morphological preference for the Black Carbon depending on the snow origin: Black Carbon found in snow from Greenland has fewer monomers arranged in a chain like shape, while Black Carbon found in snow from Alaska has a large number of monomers arranged in a compact shape. These preliminary results show that electron microscopy can be used for morphological analysis of Black Carbon accumulated in show and glaciers, and that the Black Carbon particles present morphological differences depending on their origin.
Future work will focus on measuring the Black Carbon size distribution from the electron micrographs and analyzing the correlation between the particle size, morphology and collection place.

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