X-Ray fluorescence microprobe analysis of marine macrofoulers

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The measurements were performed at the XRF microprobe beamline FLUO at ANKA (2), KIT, Germany using the following parameters:
- Bending magnet beamline providing a monochromatic 17 keV X-ray beam
- A scanning step size of 15 µm was chosen to match the focus size of the capillary focusing the beam on the sample.
- Unfocused detection of the XRF signal yields an projection-type map of elemental distributions. The depth visibility of different elements depends on the penetration depth of the X-ray energy corresponding to the XRF line.
- Confocal scans using another capillary in front of the detector allow for a depth-resolution similar to the lateral resolution. Confocal measurements are severely limited by the signal intensity which is orders of magnitude lower compared to an unfocussed detection.

ACKNOWLEDGMENTS

COLLABORATIONS

Glossary

0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0

IN SITU SAMPLE ENVIRONMENT

TUBEWORM MEASUREMENTS

LENGTH SCALES

BARNACLE MEASUREMENTS

X-RAY FLUORESCENCE MICROPROBE ANALYSIS

Fitting the spectrum with the known positions of the XRF peaks of the elements in the sample yields the concentrations of these elements. Combining a small X-ray focus size with a scanning sample stage turns this spectrosopy technique into a valuable imaging tool which provides elemental distribution maps of the sample.

Elemental distribution maps and optical micrograph of a barnacle (Chthamalus stellatus). The scan area measures 285 µm x 205 µm. The barnacle organism had been settled on Kaption 6 days prior to the measurement. The outer shell contains Ca, K, Mn, and Sr in the anterioal region. As, Br, Cu, Fe and Zn can be found. Pb and Sr are present as well, albeit in minute concentrations.

Elemental maps and an optical micrograph of a recently settled barnacle (Chthamalus stellatus) in the metamorphic stage. The scan area measures 370 µm x 450 µm. This can be achieved using a confocal setup and hence shows only the elements present directly at the surface. Br and Cu are the first elements present in the outer phase of the horn formation, when Ca has not yet been incorporated. Br, Cu, Fe, K, Mn, Na and Zn can be found in the anterioal region, while As is distributed all over the contact area.

Elemental distribution maps of a barnacle (Chthamalus stellatus). The barnacle organism had been settled on Kaption 8 days prior to the measurement. The size of the scan area is 750 µm x 830 µm. Ca, K, Mn, Sr and Zn can be found in the outer shell. The distribution of these elements correlates quite strongly. Cu, Fe and Zn are located in the anterioal region, as well as As and Ni in lower concentrations.

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