Obtainable results by Scanning Electron Microscopy (SEM) in
Riga Technical University Institute of General Chemical Engineering

**Scanner electron microscopy by secondary electron detector (SEM-SE)**

+ Surface morphology analysis
+ Extensive microstructure data: sample homogeneity, porosity, and crystallite size, shape and distribution on the surface or fracture (by volume)
+ Sample surface side view (tilting and rotation)
  – Images are black and white, no recognition of different colourful phases
  – If the surface is smooth, then additional sample treatment could be required, e.g. etching
  – Good for conductive samples
  – Data interpretation requires experience

**Scanner electron microscopy by backscattered electron detector (SEM-BSE)**

+ Method for studying phase microstructure in the plane; the phases with a different density and conductivity gives different brightness – heavy element containing phases are brighter than light element containing phases, for example, calcium phosphates (dark grey) can be easily distinguished from niobium containing phases (light grey and white). Phase distribution analysis?
+ SEM-BSE and SE combination is possible
  – Two dimensional images
  – The sample must be flat and with smooth surface
  – Additional data is required for interpretation of phase composition

Figure. The same spot of sample: on left – SEM SE, on right – SEM BSE
Obtainable results by Scanning Electron Microscopy (SEM) in
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**Scanning electron microscopy energy-dispersive X-ray spectroscopy (SEM-EDS or SEM-EDXS)**

- Qualitative and quantitative elemental analysis; chemical composition of each phase can be determined
- Composition gradient can be easily determined
- The size of analysed phase (grain) may be very small (~ 5-15 µm)
- Spot, line and area analysis
  - Spot size depends on molecular weight of sample, for lighter phases it is bigger
  - Analysing too small or thin grain, the result can also include the elemental composition of the surrounding environment
  - Some elements might have overlapping peaks
  - Sample surface must be flat, ideally – polished
  - Knowledge of approximate chemical composition eases the analysis

**Example of SEM-EDS result table:**

Processing option: All elements analysed (Normalised)

<table>
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<tr>
<th>Spectrum</th>
<th>In stats.</th>
<th>O</th>
<th>Na</th>
<th>Al</th>
<th>P</th>
<th>Ca</th>
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All results in atomic%