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

Scanning 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
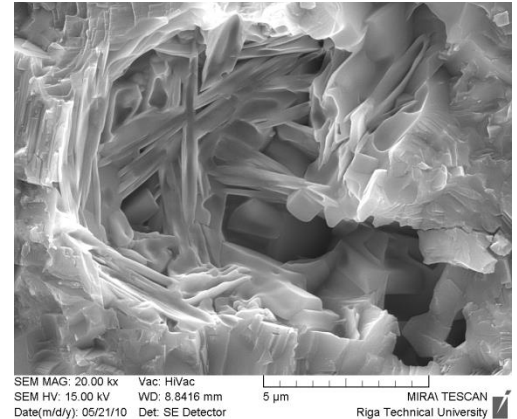
Scanning electron microscopy by backscattered electron detector (SEM-BSE)

+ 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

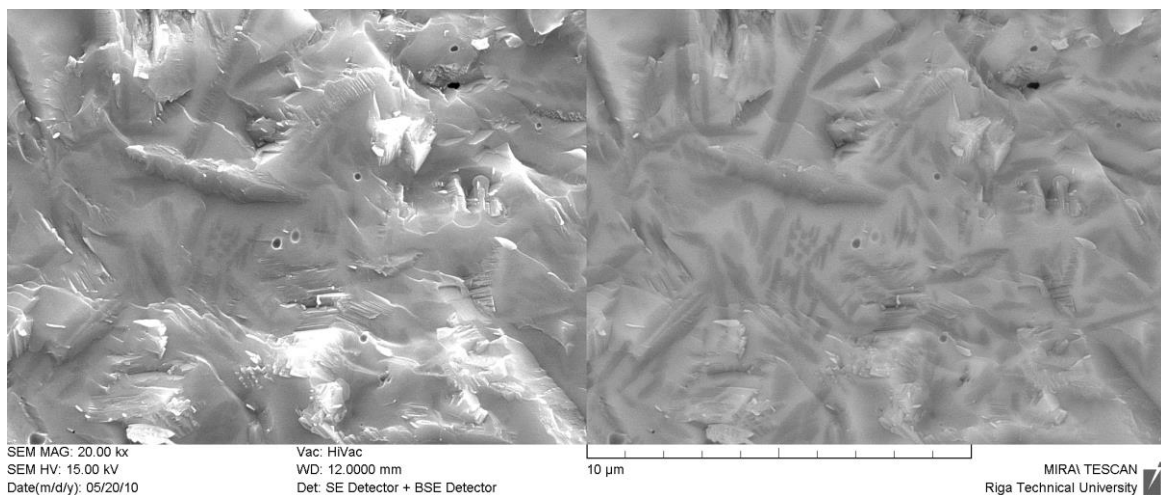− Additional data is required for interpretation of phase composition

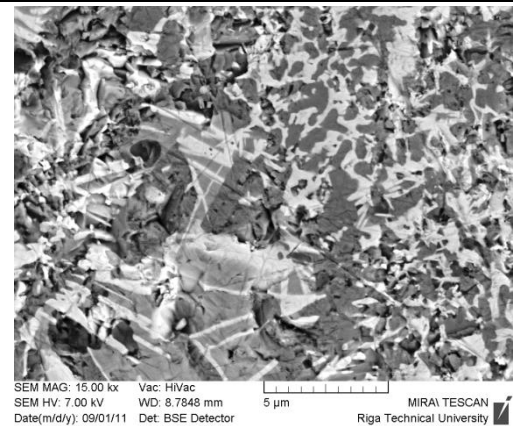Figure. The same spot of sample: on left − SEM SE, on rigt − SEM BSE

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
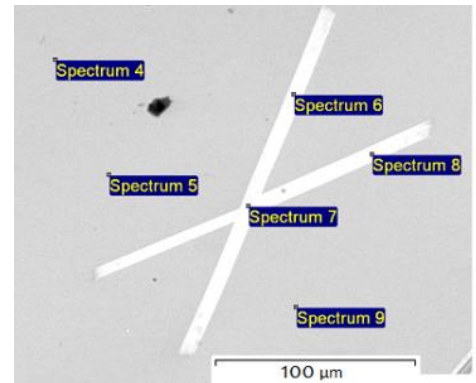
Example of SEM-EDS result table:

Processing option: All elements analysed (Normalised)

Spectrum	In stats.	O	Na	Al	P	Ca	Nb
Spectrum 1	Yes	73.58	2.16	0.39	8.00	1.19	14.67
Spectrum 2	Yes	73.11	0.78		3.64	0.58	21.89
Spectrum 3	Yes	75.83	0.71		3.44	0.64	19.37
Spectrum 4	Yes	73.28	2.23	0.35	8.03	1.33	14.78
Spectrum 5	Yes	74.46	2.22		7.87	1.12	14.33
Spectrum 6	Yes	73.98	0.81		5.19	0.58	19.44
Spectrum 7	Yes	73.09	0.90		5.62	0.76	19.63
Spectrum 8	Yes	75.63	0.58		4.82	0.51	18.46
Spectrum 9	Yes	74.54	2.54		7.39	1.32	14.20
Max.		75.83	2.54	0.39	8.03	1.33	21.89
Min.		73.09	0.58	0.35	3.44	0.51	14.20

All results in atomic%