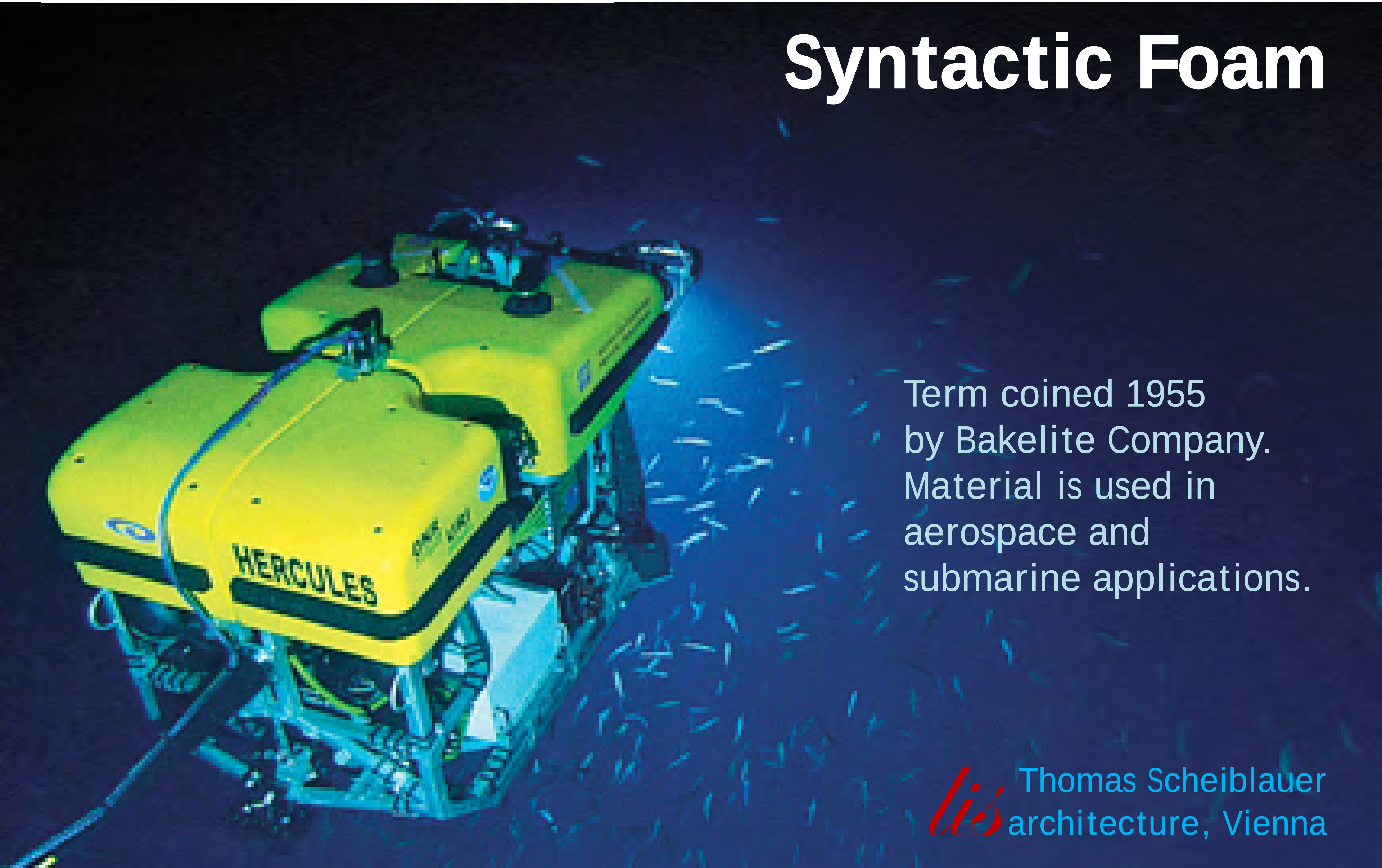
GEOPOLYMERCAMP 2015

Are Fireproof Geopolymer-Matrix Based Syntactic Foams Feasible?

lis Thomas Scheiblauer
architecture, Vienna

GEOPOLYMERCAMP 2015

Syntactic Foam



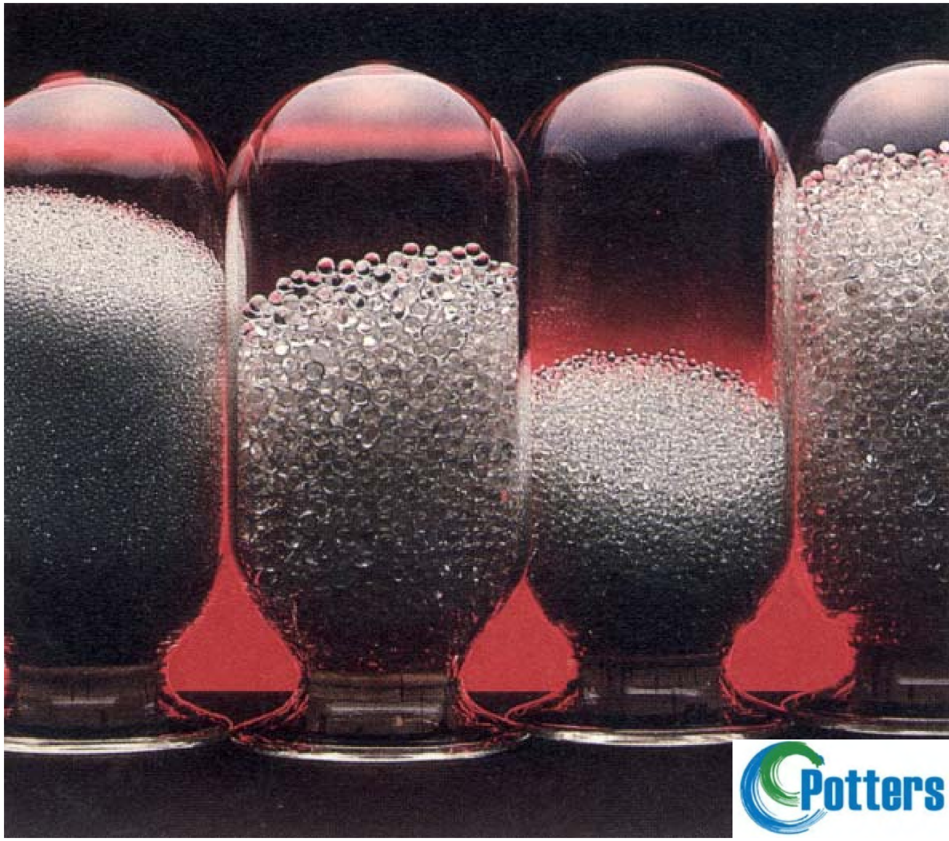
Term coined 1955
by Bakelite Company.
Material is used in
aerospace and
submarine applications.

Thomas Scheiblauer
architecture, Vienna

GEOPOLYMERCAMP 2015

Microspheres

Hollow metal, glass or ceramic **microspheres** are embedded in metal, polymer or ceramic matrix.



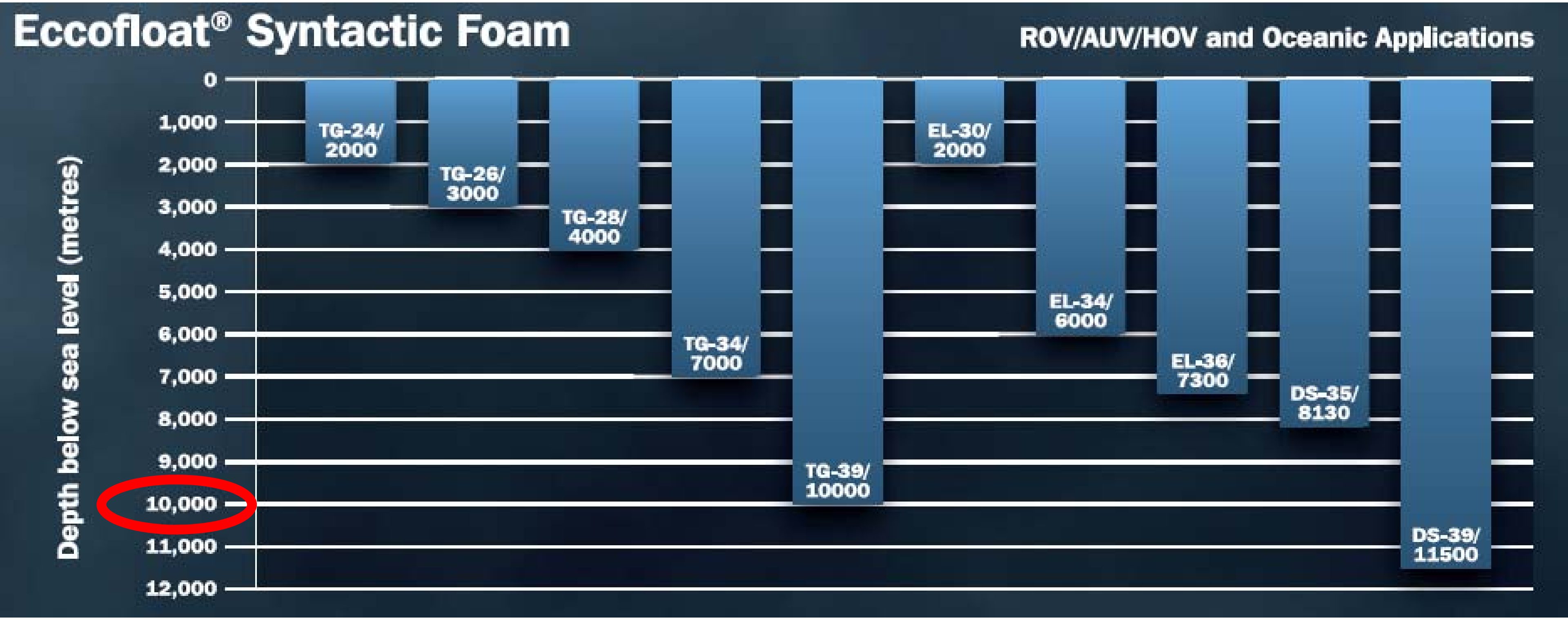
Manufacturers

3M

Potters

TRELLEBORG

Thomas Scheiblauer
architecture, Vienna



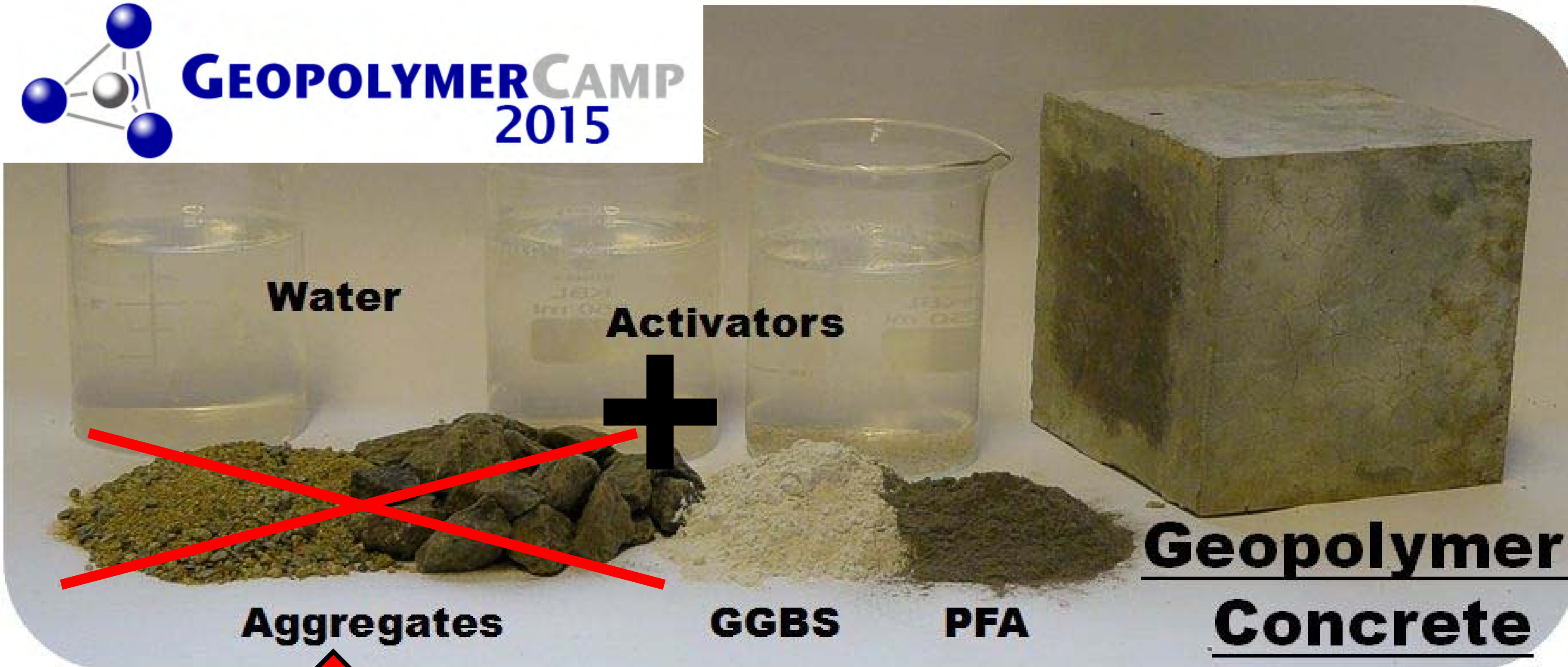
Pressure at **5 000 m** below sea level = **49.14 MPa** (7 126 psi)

Pressure at **10 000 m** below sea level = **98.17 MPa** (14 238 psi)

High performance concrete: **50-110 MPa**

Thomas Scheiblauer
architecture, Vienna

GEOPOLYMERCAMP 2015



Geopolymer Syntactic Foam

GSF

Thomas Scheiblauer
architecture, Vienna

GEOPOLYMERCAMP 2015

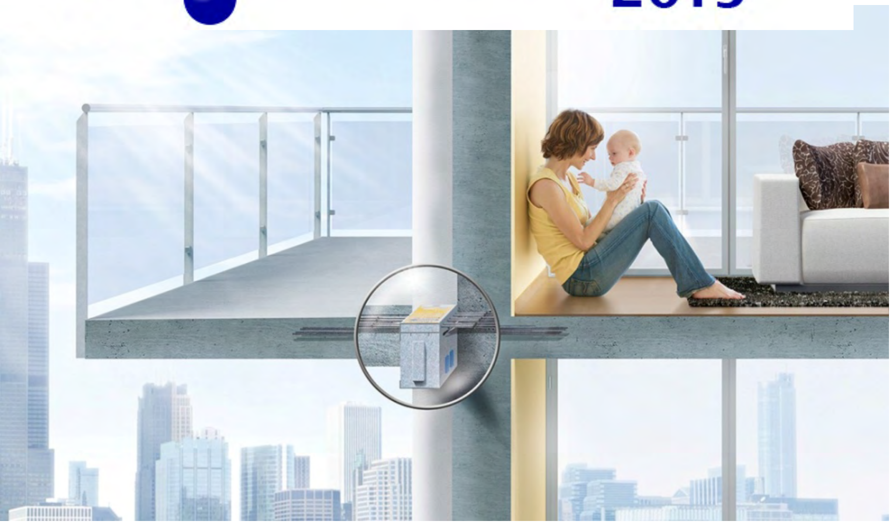
Microsphere Materials

5.3 Macroscopic (a) as well as microscopic (b) views of glass microspheres. (Courtesy Trelleborg.)

- **Hollow glass** microspheres: marine applications
- **Plastic** microspheres
- **Cenospheres**: low-density, hollow, free-flowing alumino-silicate microspheres
- **Ceramic** microspheres: paints and coatings
- **Carbon**: Phenolic microspheres can be carbonized or pitch can be treated and carbonized to produce carbon spheres
- **Aluminum** and copper/silver microspheres are currently available
- **Solid** glass microspheres, commonly called glass beads, are widely used as resin extenders

Thomas Scheiblauer
architecture, Vienna

GEOPOLYMERCAMP 2015



Applications

lis Thomas Scheiblauer
architecture, Vienna

GEOPOLYMERCAMP 2015

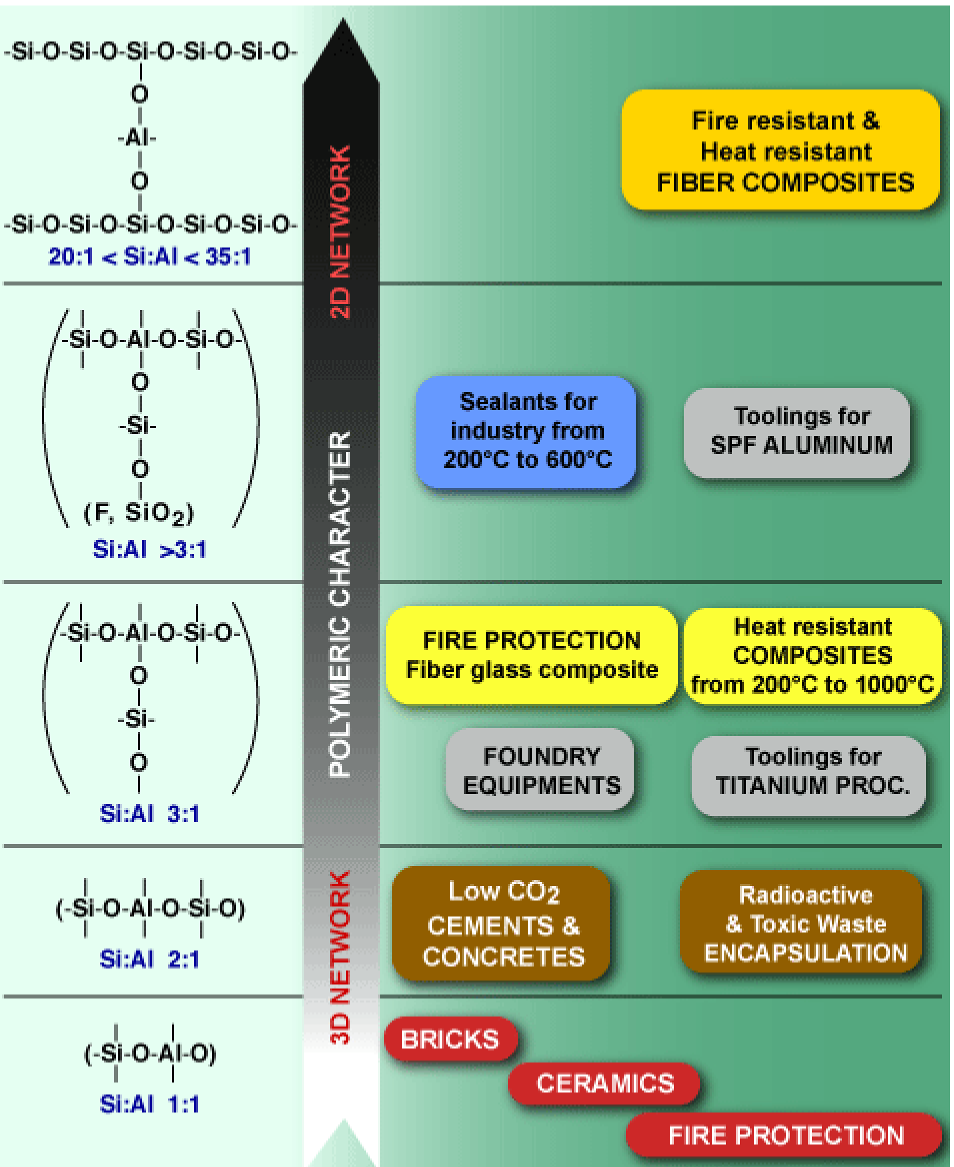
Le Corbusier, 1931
Villa Savoye
82 Rue de Villiers
78300 Poissy

Today: thermal insulation required!

Thomas Scheiblauer
architecture, Vienna

GEOPOLYMER CAMP 2015

Geopolymer of interest



Thomas Scheiblauer
architecture, Vienna

How to Make a Fire Resistant Geopolymer

Geopolymere Institute, 1997:

Fire Resistant Aluminosilicate Composites

Lyon, Balaguru, Foden, Sorathia, Davidovits

“The Geopolymer potassium aluminosilicate resin was prepared by mixing 100 g of an aqueous silica + potassium oxide solution with 135 g of silica powder having SiO_2/AlO_2 in a mole ratio of 27/1.“

A/N: potassium waterglass (K_2SiO_3) + silica fume, weight ratio approximately 3:4

Thomas Scheiblauer
architecture, Vienna

Questions

- Are there alcali resistant microspheres and fibers?
- How do the binders mix with microspheres?
- How do fibers influence tensile strength?
- Thermal conductivity?
- Compressive strength?

Thomas Scheiblauer
architecture, Vienna

GEOPOLYMERCAMP 2015

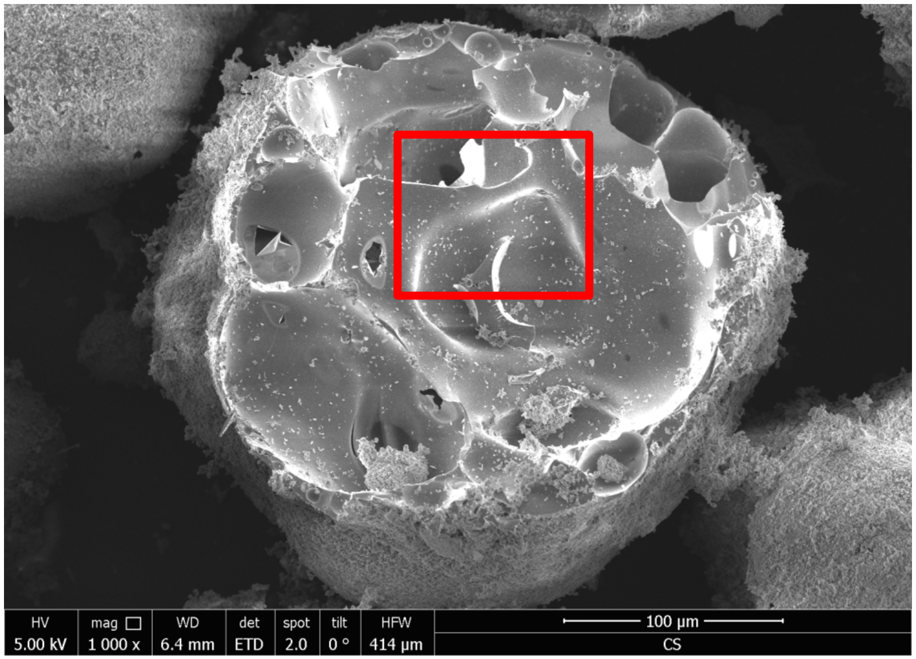
First experiments with silica fume / pc concrete

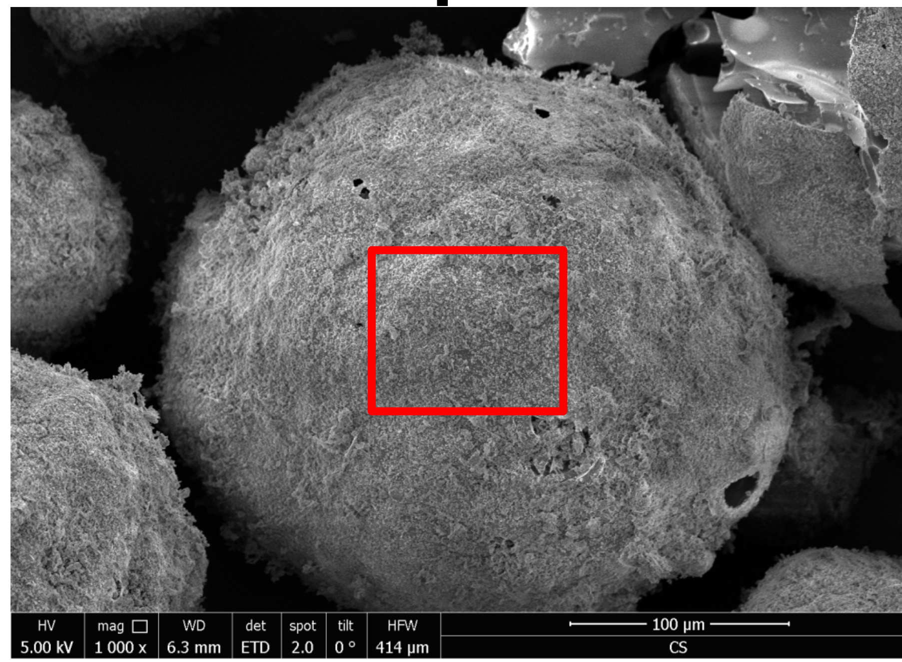
Vienna, June 2015

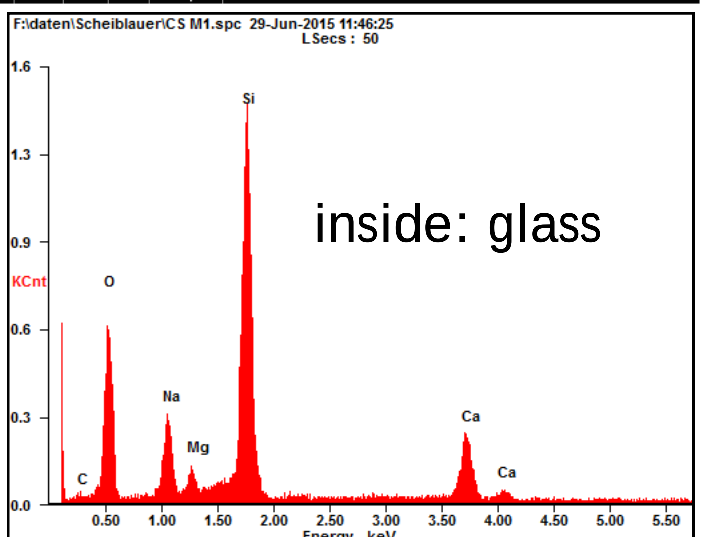
DI Martin Murero
DI Thomas Scheiblauer
DI Peter Sedlak

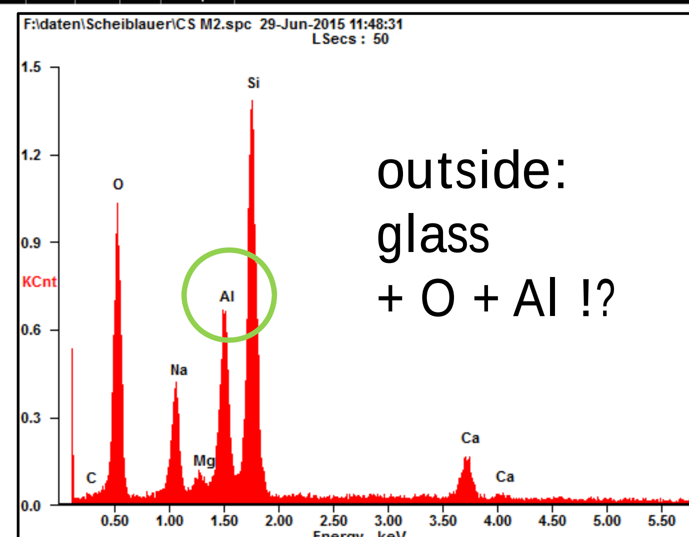
GEOPOLYMERCAMP 2015

Electron microscopy and EDX-spectra



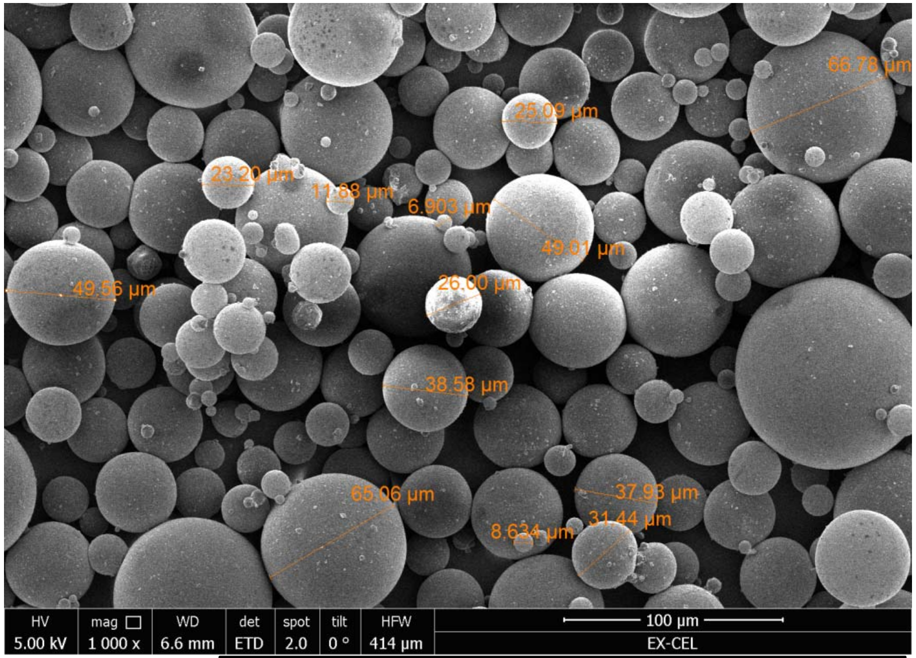


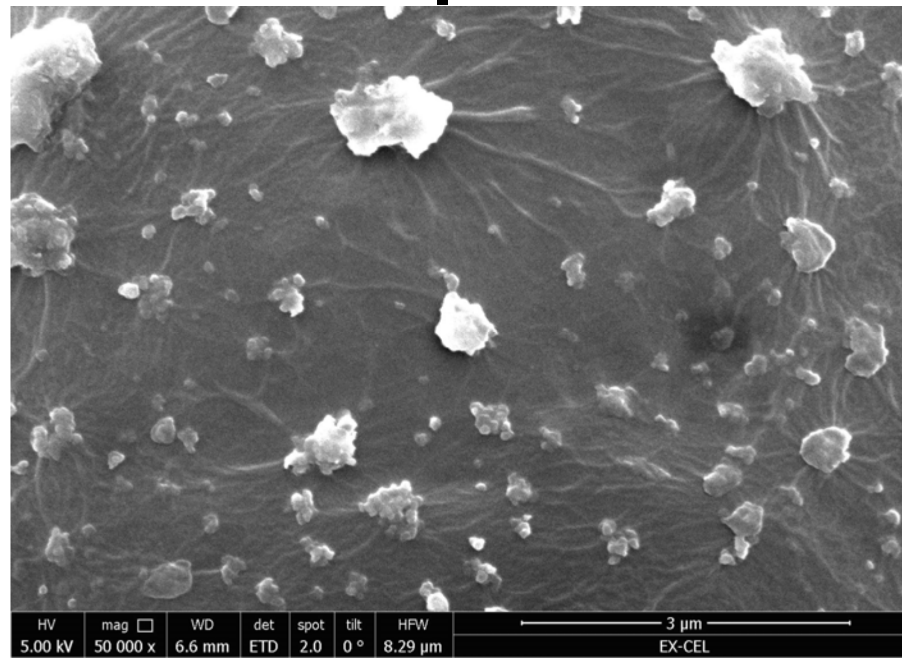


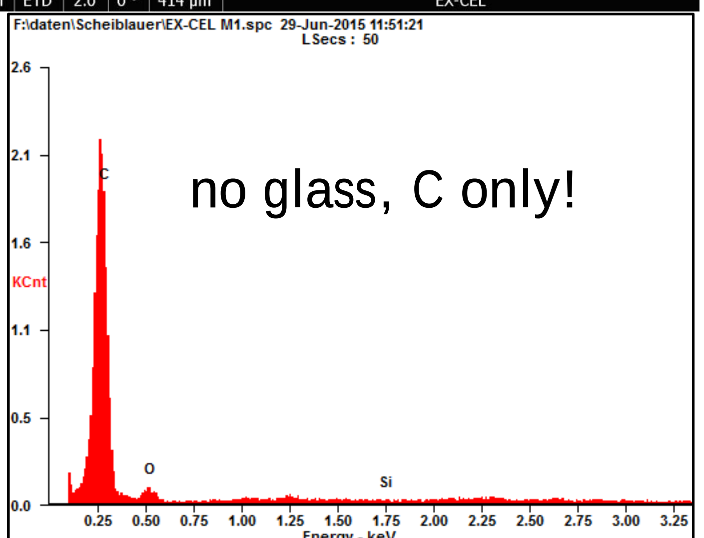


GEOPOLYMERCAMP 2015

Electron microscopy and EDX-spectra



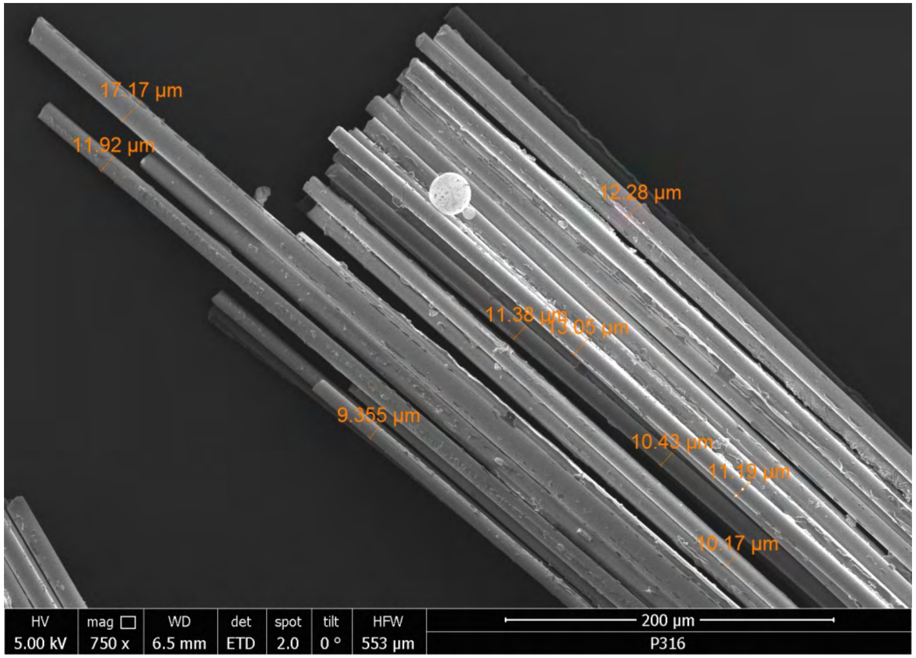


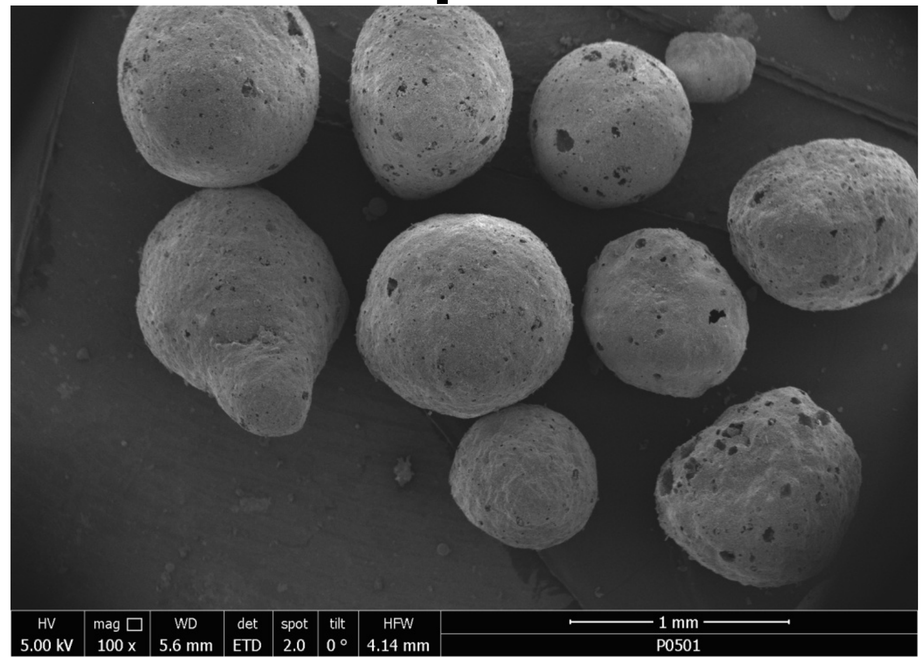


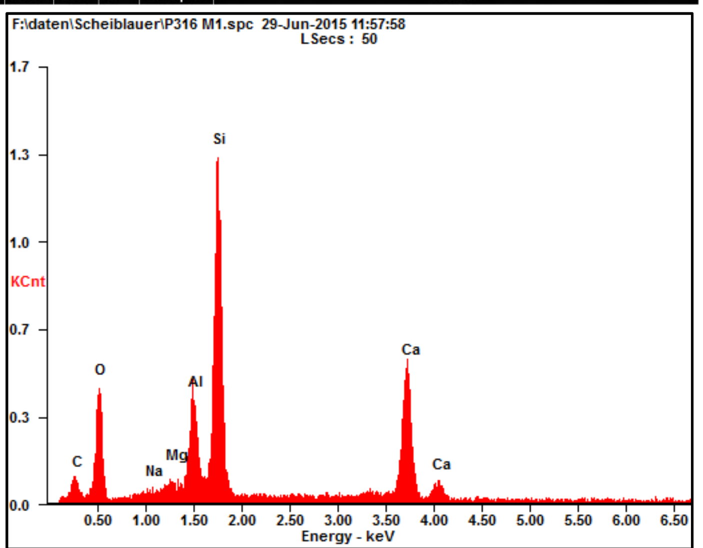
(EDX = Energy-Dispersive X-ray spectroscopy)

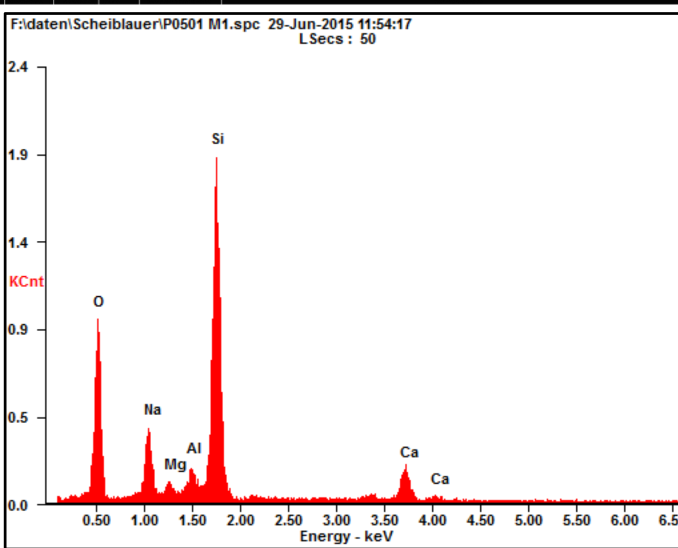
Thomas Scheiblauer
architecture, Vienna

Electron microscopy and EDX-spectra

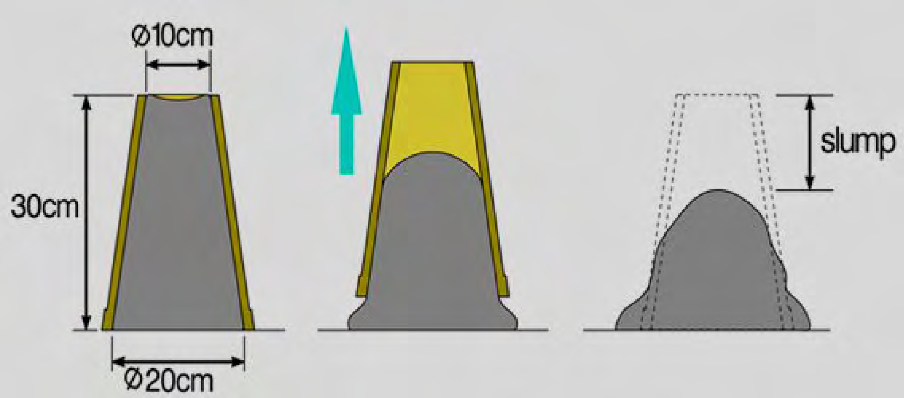






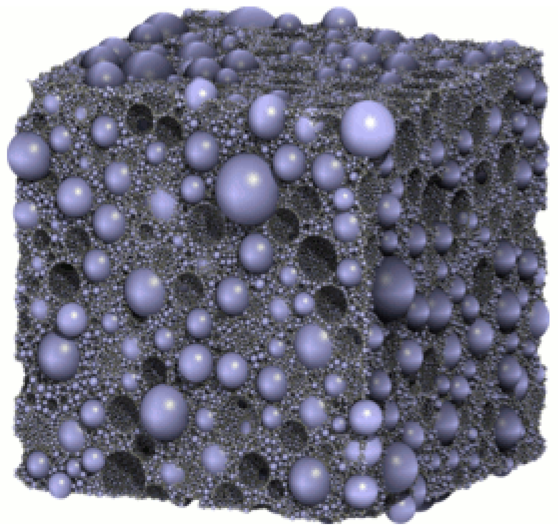


GEOPOLYMERCAMP 2015



Requirements

- **Alkali resistant microspheres with high compressive strength**
- **Alkali resistant fibers with high tensile strength**
- **Chloride resistance** (with steel)



- **Freezing and thawing resistance** (necessary air content)
- **Optimal microsphere size distribution**
- **Percentages of fly ash, slag, silica fume**
- **Slump control**

Thomas Scheiblauer
architecture, Vienna