

Porézní materiály pro adsorpci a katalýzu

Jiří Pinkas

Ústav chemie, Přírodovědecká fakulta, Masarykova univerzita

M U N I
S C I



jpinkas@chemi.muni.cz

Mezoporézní metalosilikátové, organosilikátové a metalofosfátové materiály s vysokým měrným povrchem

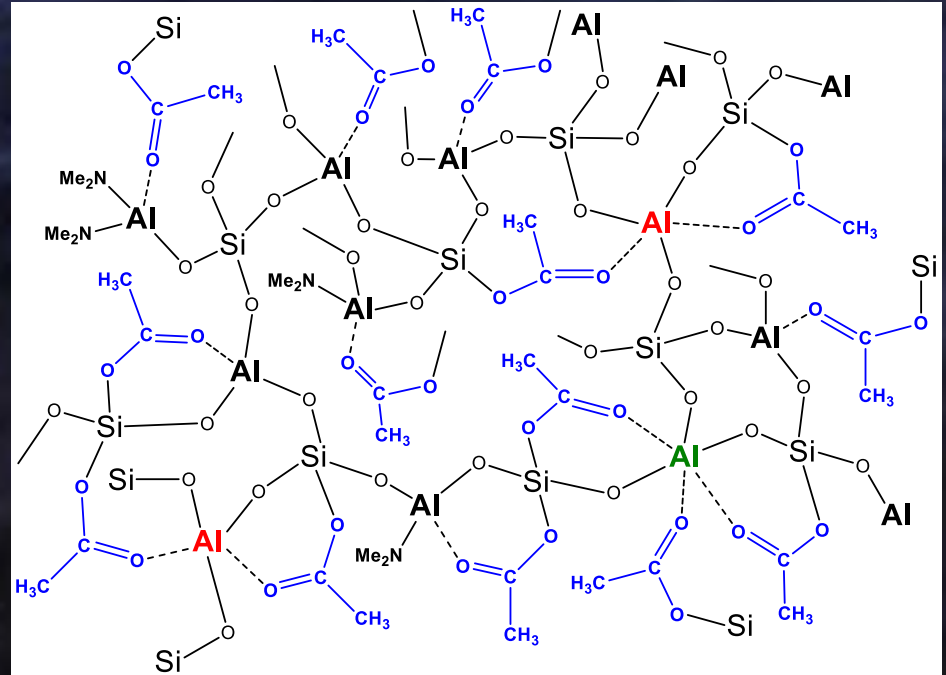
Sol-gelové metody - hydrolytické a nehydrolytické polykondenzační reakce

Hybridní organosilikáty

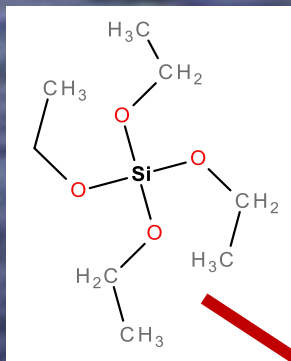
Fosforečnany křemičité

Metalokřemičitany

Hlinitofosforečnany a fosfonáty

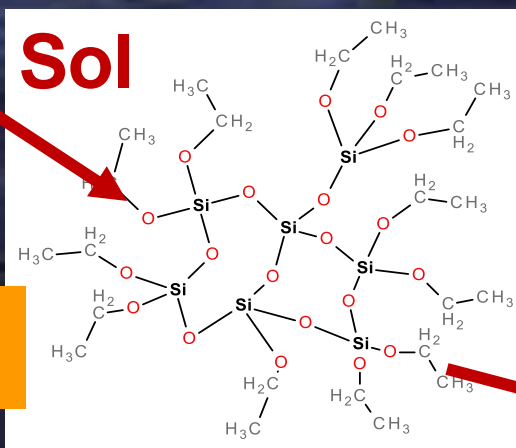


Sol-Gelový proces

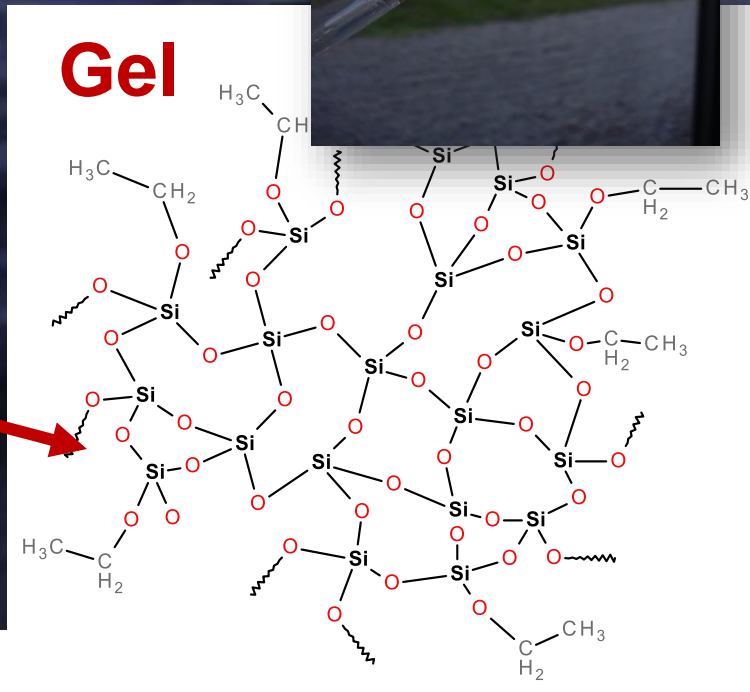


TEOS

Roztok molekulárního
prekurzoru



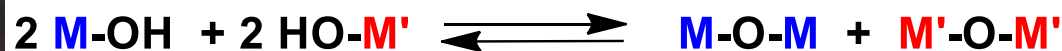
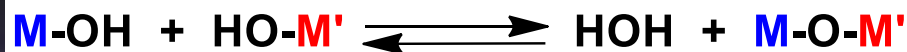
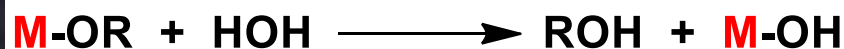
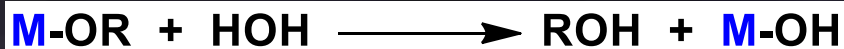
Koloidní roztok



Polymerní síť - silikagel

Mikro pod 2 nm
Meso 2 - 50 nm

- 1) Hydrolýza
- 2) Polykondenzace



Nehydrolytická sol-gelová metoda

Polykondenzace = eliminace malých molekul X-Z

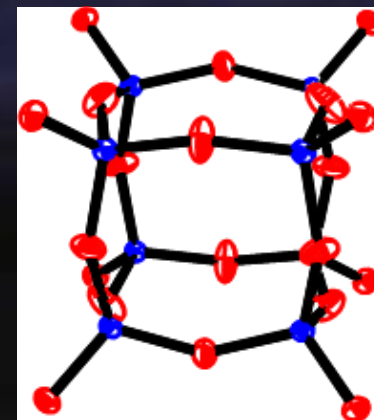
(alkyl halogenidy, ethery, estery, alkeny,....)



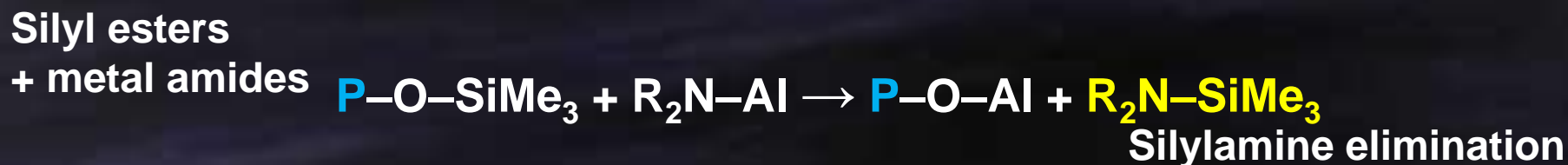
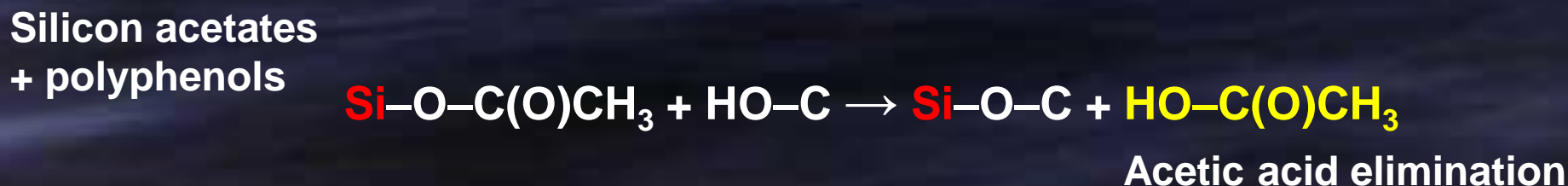
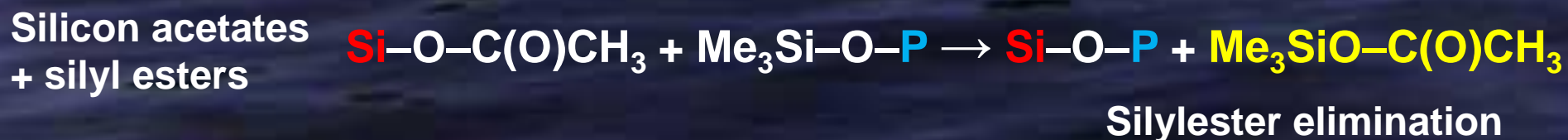
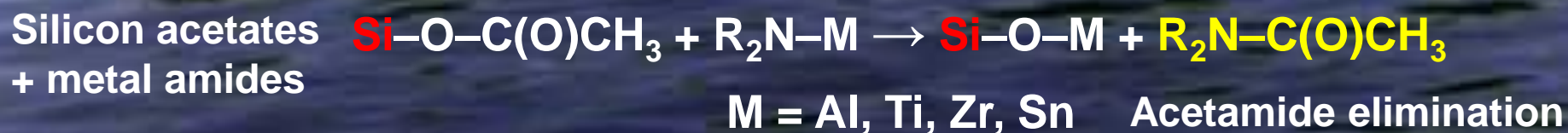
M, M' =

- monojaderné
(P, Si, Al, Ti, Y, Zr, V, Nb, Mo, W, Fe, Zn, Sn,....)

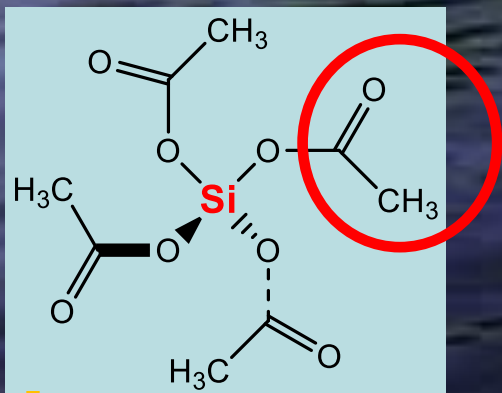
- polyjaderné klastery
 $\text{Ti}_8\text{O}_8(\text{O}_2\text{CR})_{16}$, $\text{Si}_8\text{O}_{20}\text{R}_8$, $\text{Al}_4\text{P}_4\text{O}_{12}\text{R}_8$



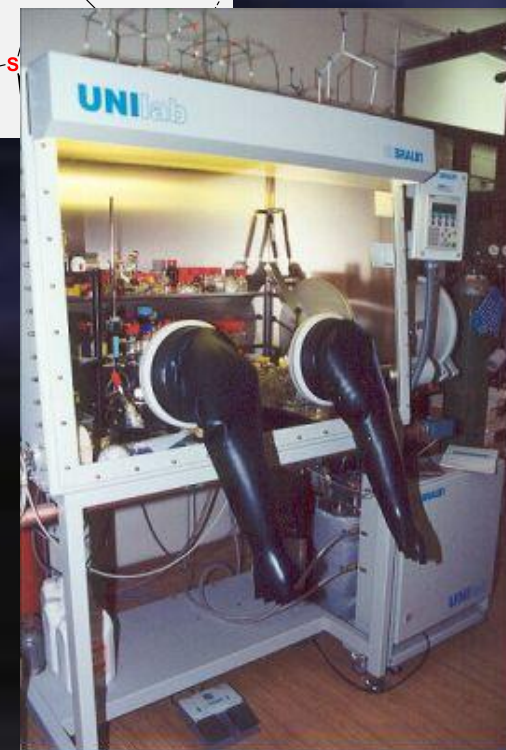
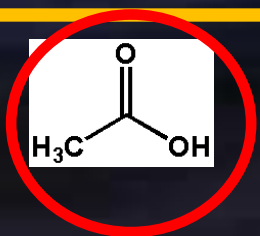
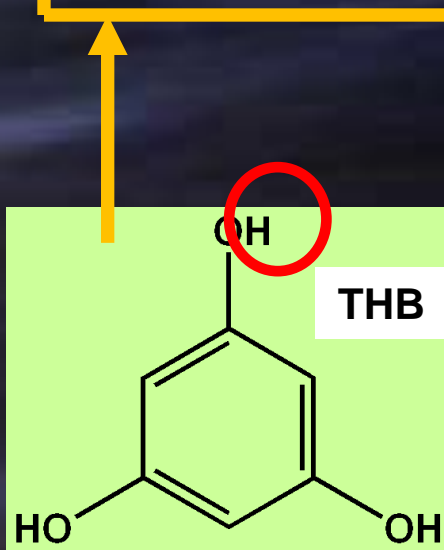
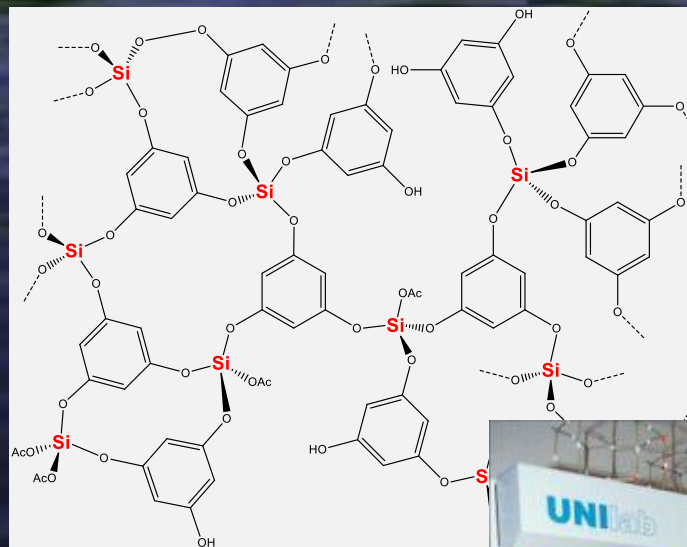
Nové polykondenzační reakce



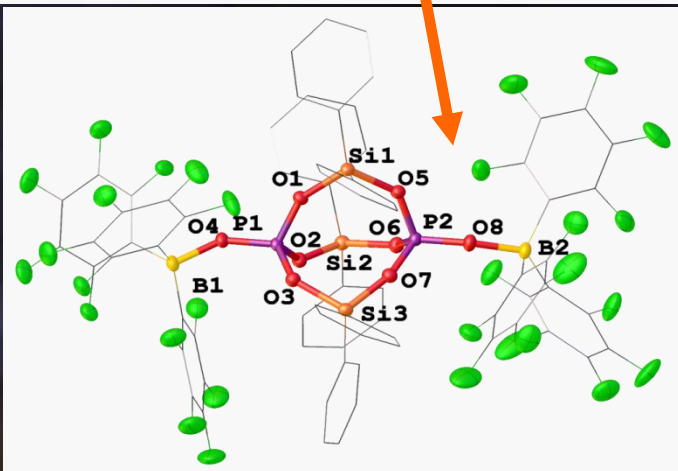
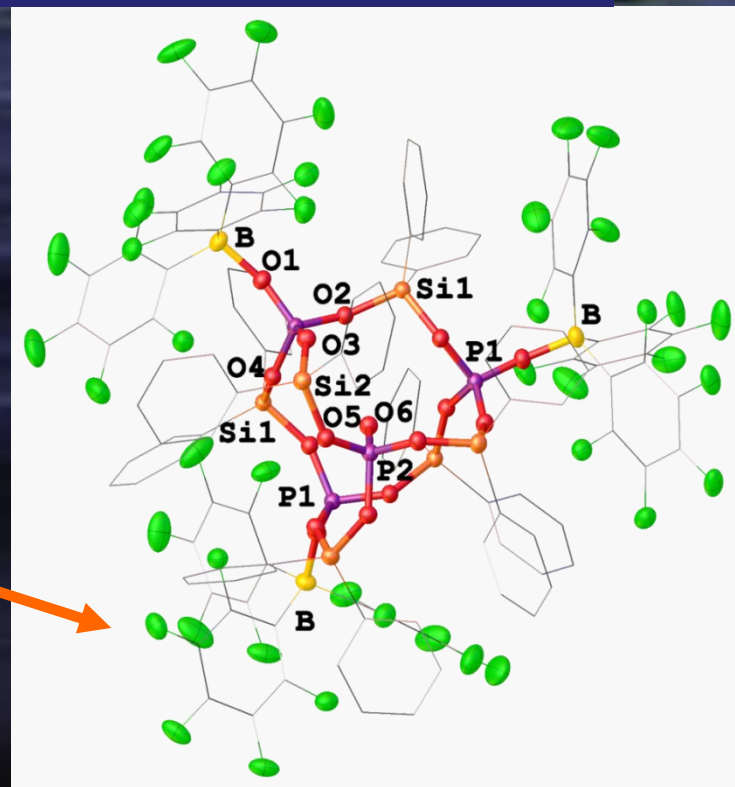
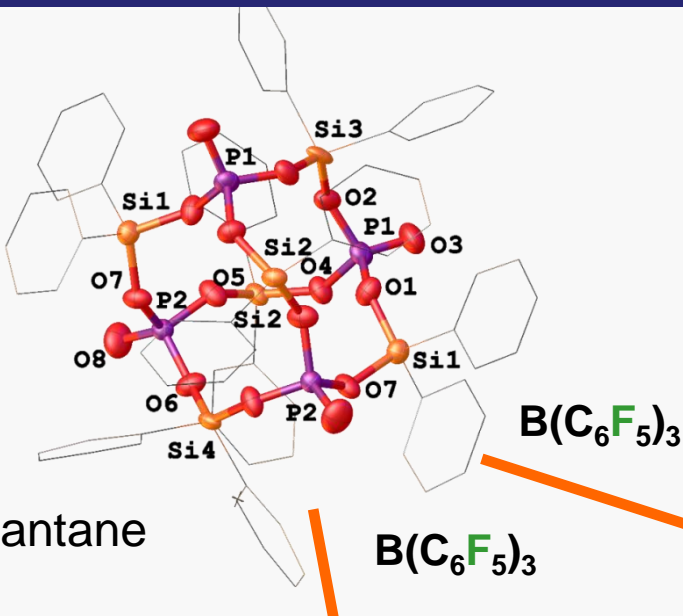
Polykondenzace s eliminací HOAc



1,4-dioxan, 100 °C, 7 dní



Molekulární Organosilikofosfáty

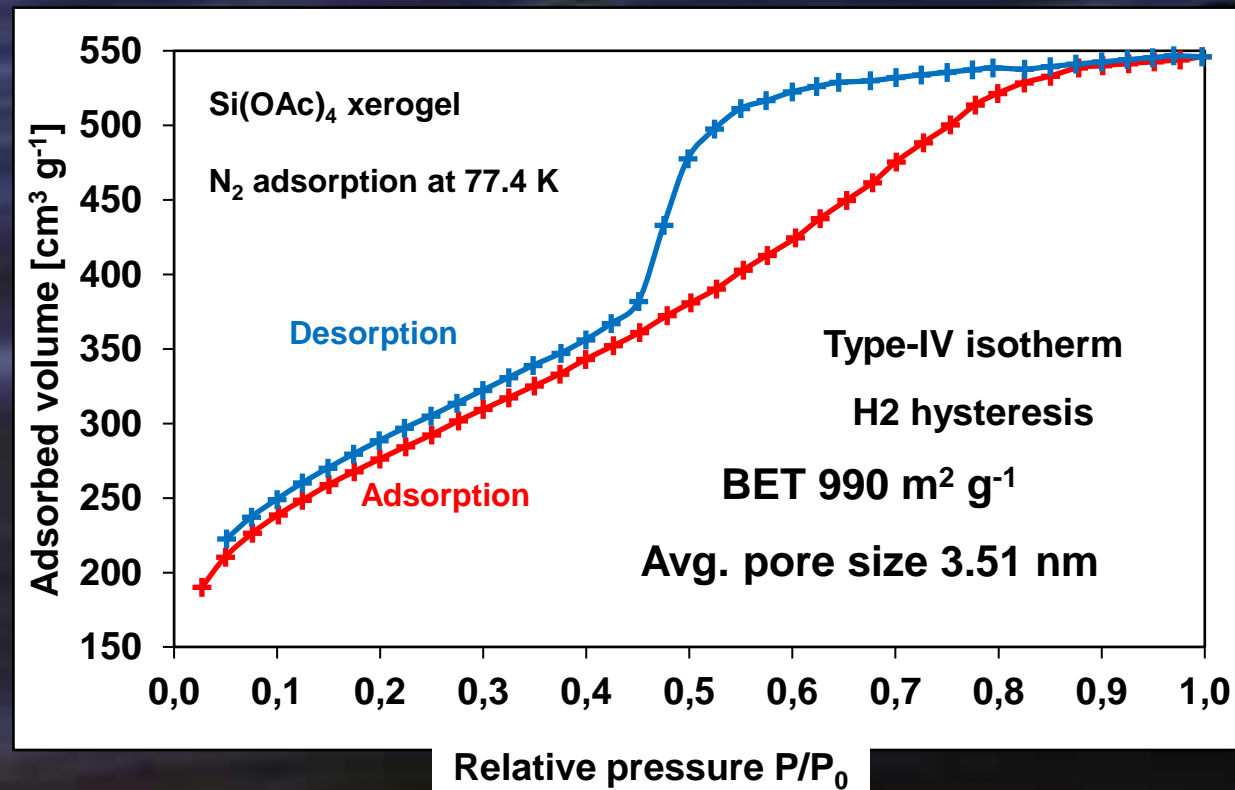


A. Styskalik, M. Babiak, P. Machac, B. Relichova,
J. Pinkas* *Inorg. Chem.* **2017**, 56, 10699–10705

Charakterizace

Adsorpce-desorpce dusíku, argonu, oxidu uhličitého a vodní páry

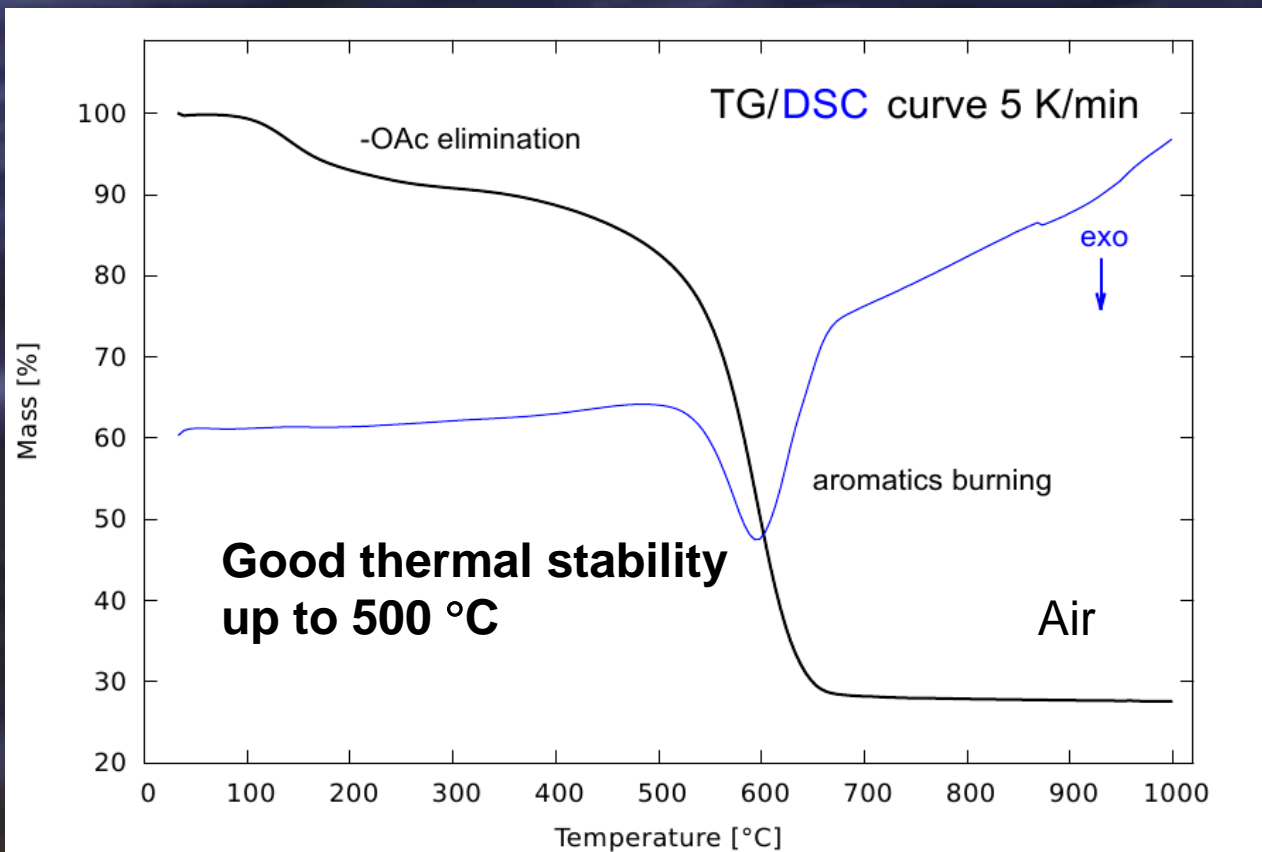
- Porozita - velikost pórů
- Měrný povrch
- Tvar pórů
- Katalytické vlastnosti



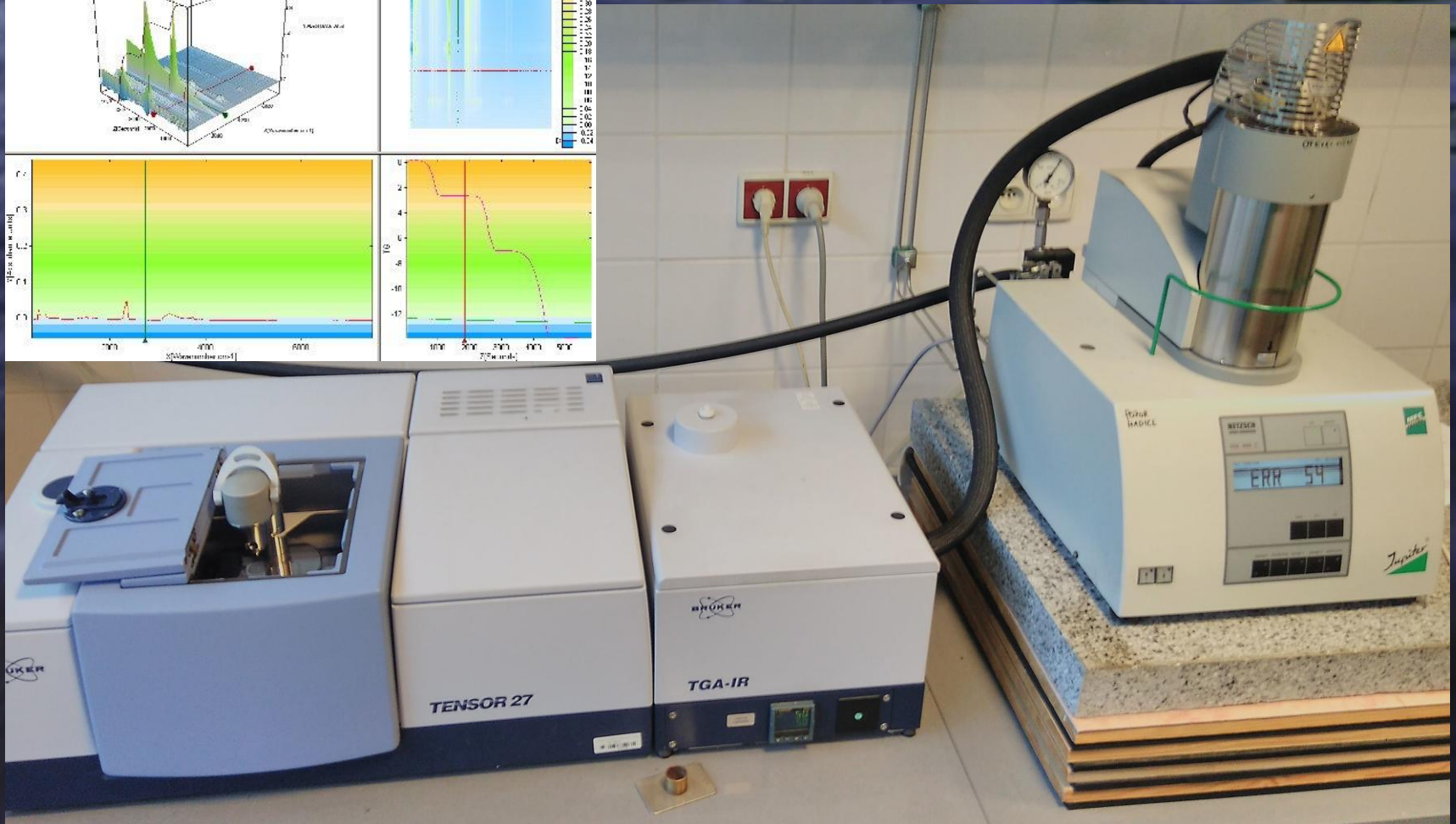
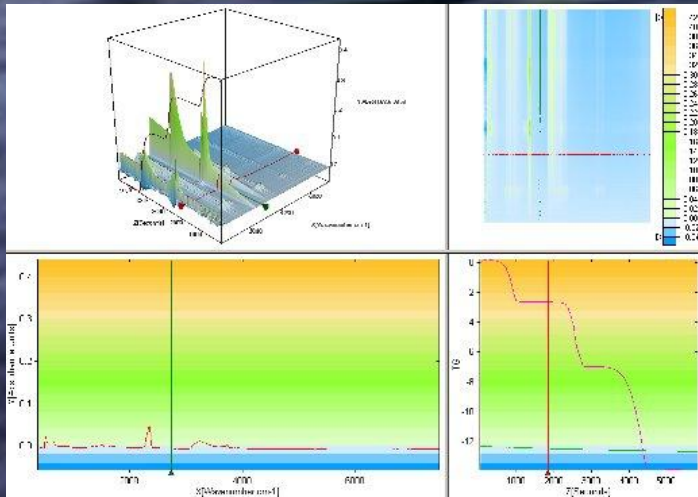
Charakterizace

Termogravimetrie a diferenční skenovací kalorimetrie

- Termická stabilita
- Krystalizace
- Unikající plyny



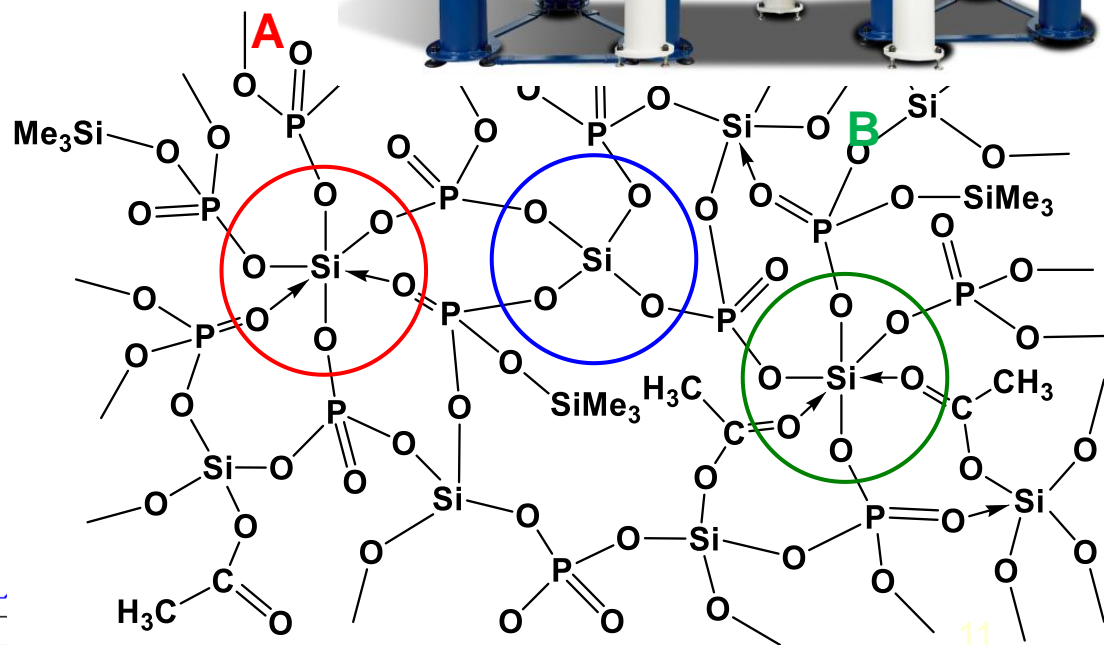
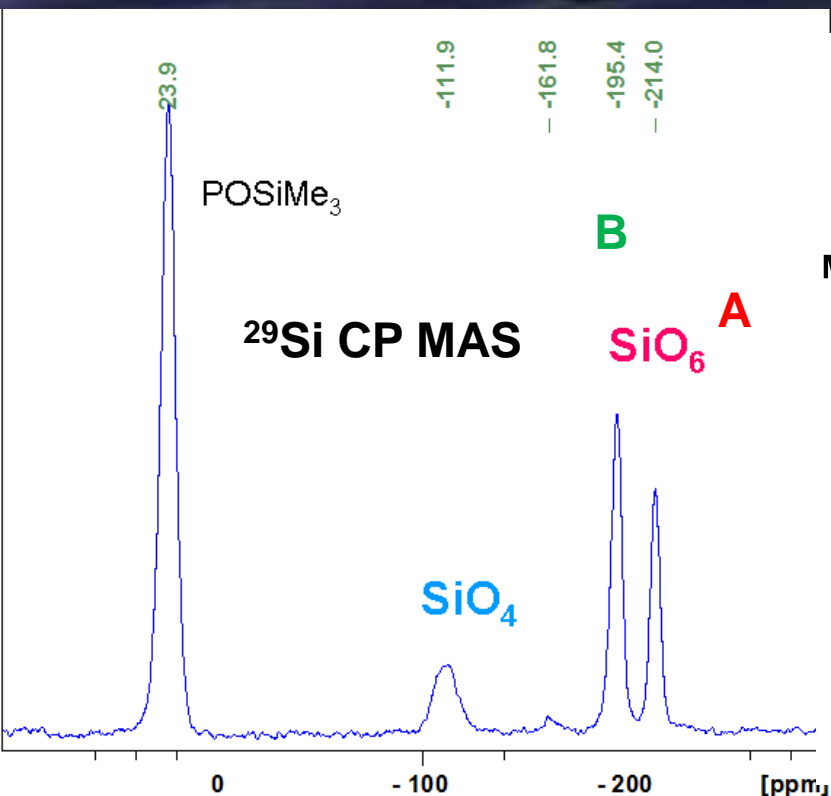
Charakterizace



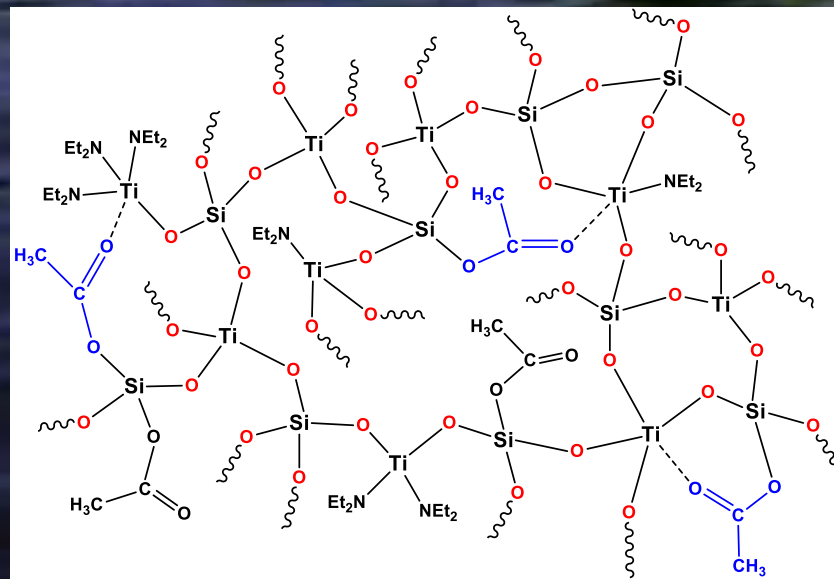
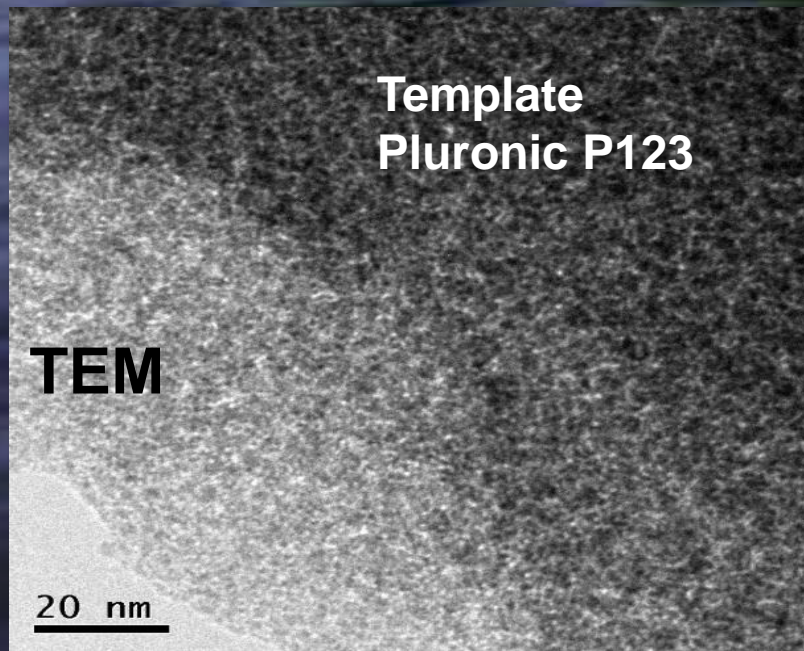
Charakterizace

NMR spektroskopie v pevné fázi

- Chemicky odlišné atomy
- Koordinační číslo



Charakterizace



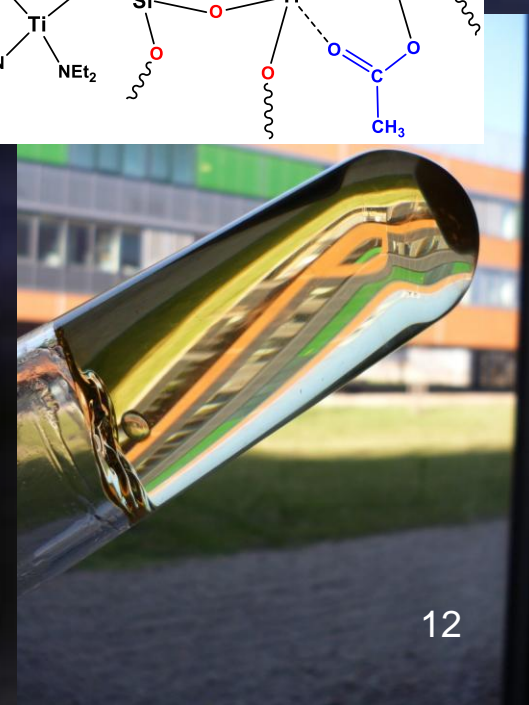
Wormhole structure

Surface areas: 326–615 m² g⁻¹

Pore diam: 2.6–7.4 nm

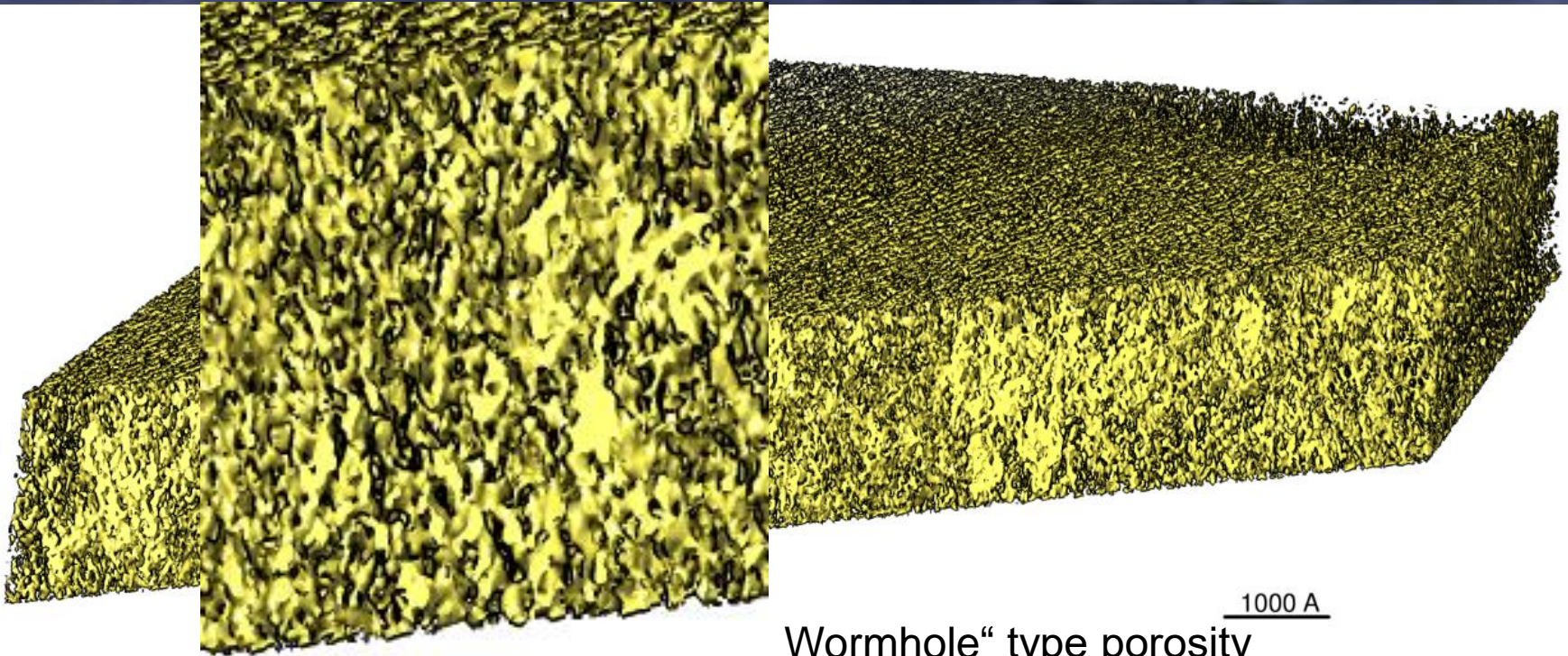
TEM - transmisní elektronová mikroskopie

- Velikost pórů
- Tvar částic a pórů



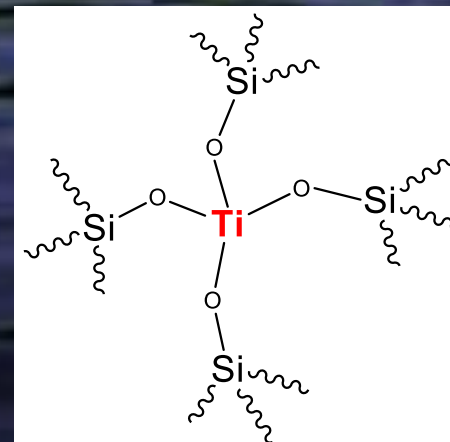
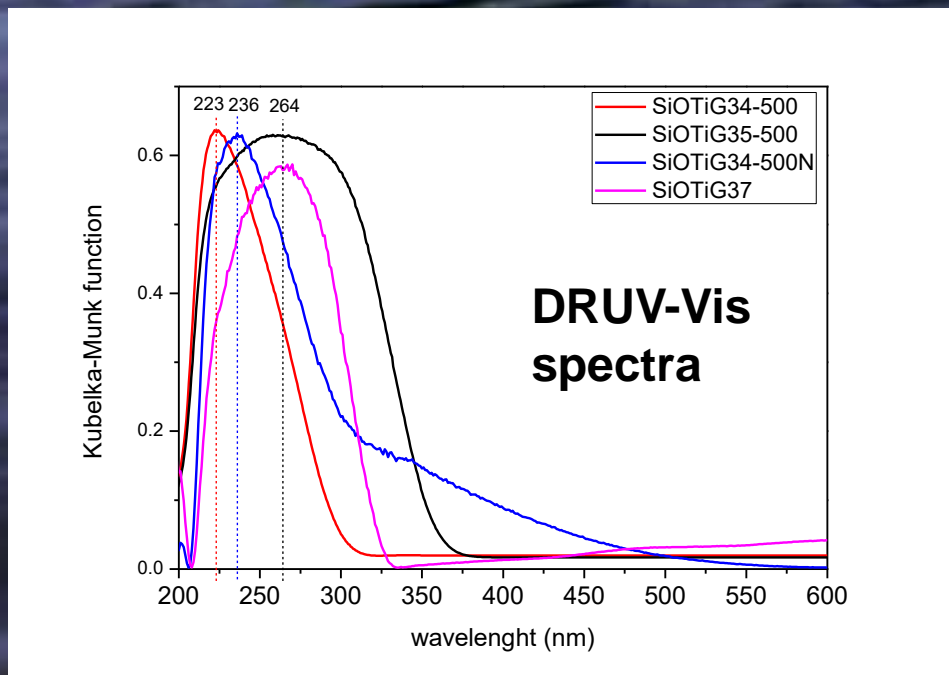
TEM Tomografie

3D model reconstruction

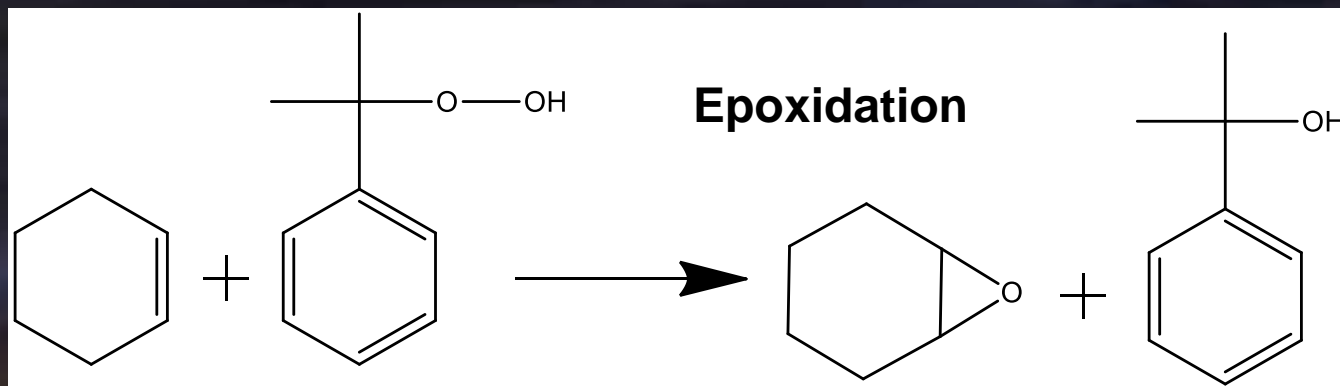


3D rendering of a reconstructed tomogram of zirconosilicate xerogel

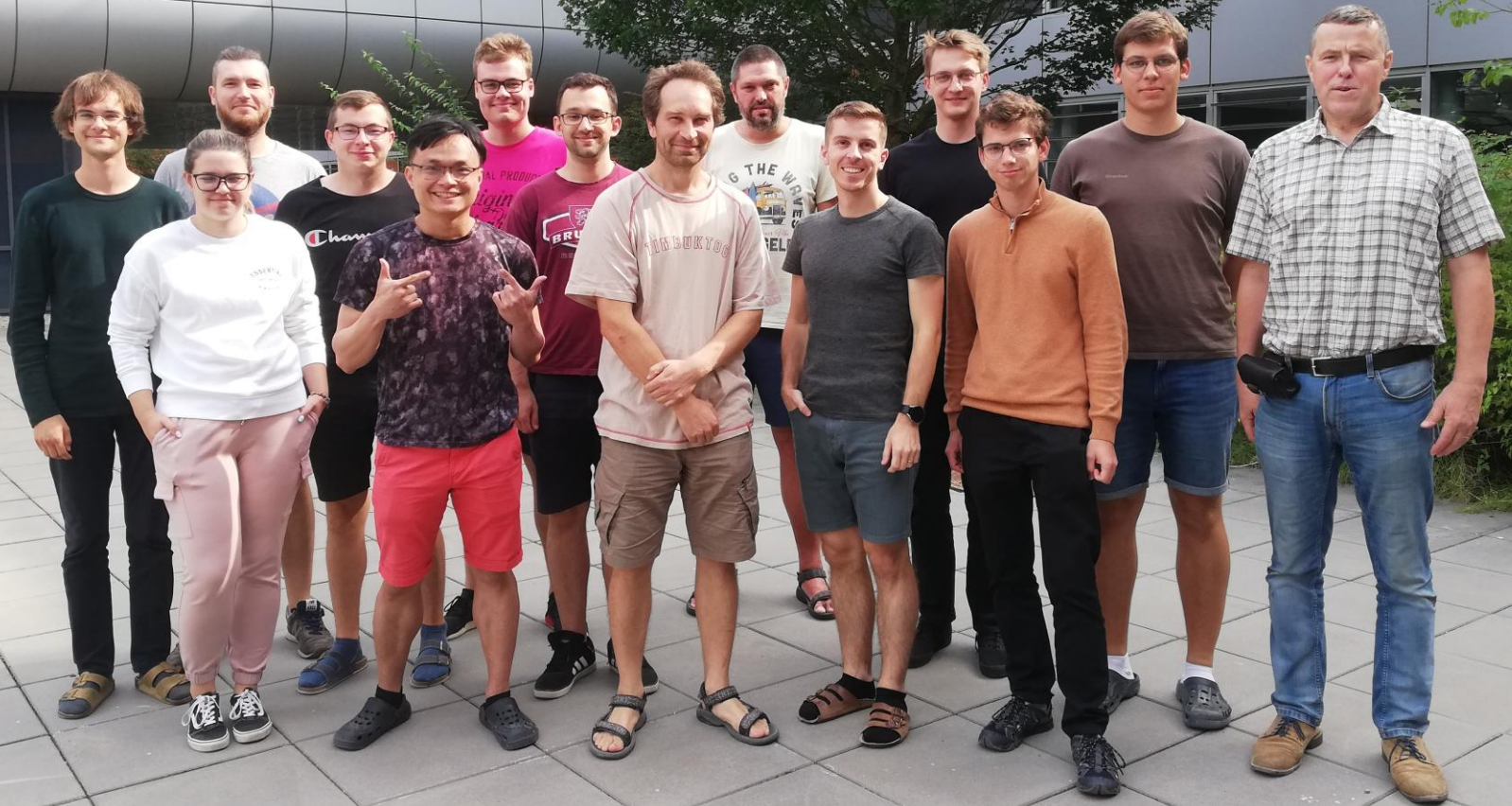
Titanosilikáty jako katalyzátory



The best catalyst
templated, calcined, ~10 % Ti
conversion 96 %, >99 % selectivity (**no alcohols**)



Děkuji za pozornost



Kontakt: jpinkas@chemi.muni.cz