The Sol-Gel Materials & Nanotechnology Center of Excellence - an overview

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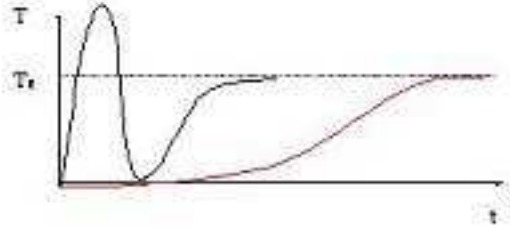
GLASS

conventional

(solid amorphous product of melting of inorganic substances)

sol-gel

(substance possessing properties of regular glass and obtained without melting)



sol - colloidal solution of particles with diameters $\phi \in (1\ nm, 100\ nm) \rightarrow$ Tyndall effect

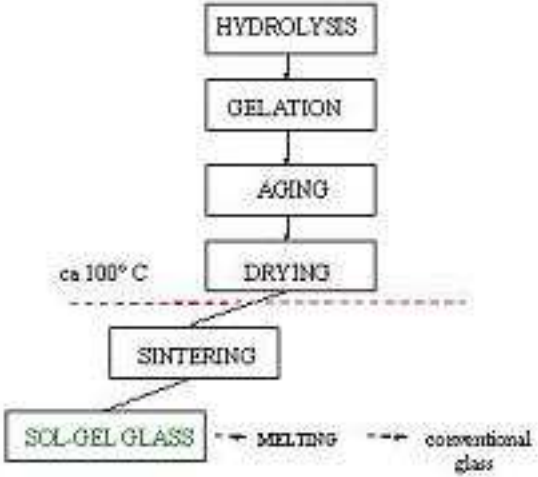
gel - (quasi)solid substance with a „spanning cluster" of internal bonds reaching from its one end to the other

sol-gel glasses – Ebelman (XIX century)
(months-long gelation of metal alkoxides)

general precursors for silicates **organoalkoxysilanes**

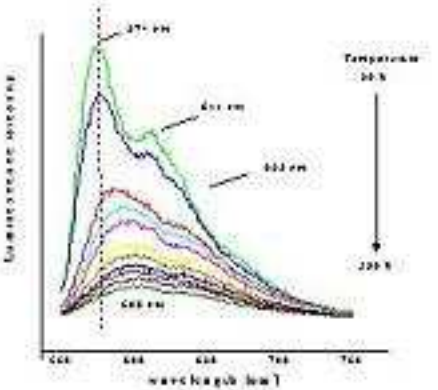
$$M(OR)_n R'_{(4-n)}$$

(typically: n = 4; M = Si, Ti, Zr; R = Et - TEOS or R = Me - MEOS)

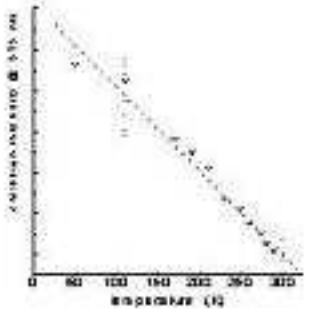


temperature optodes based on doped films

emission of $Ru(bpy)_3^{2+}$ in s-g matrix vs. temperature

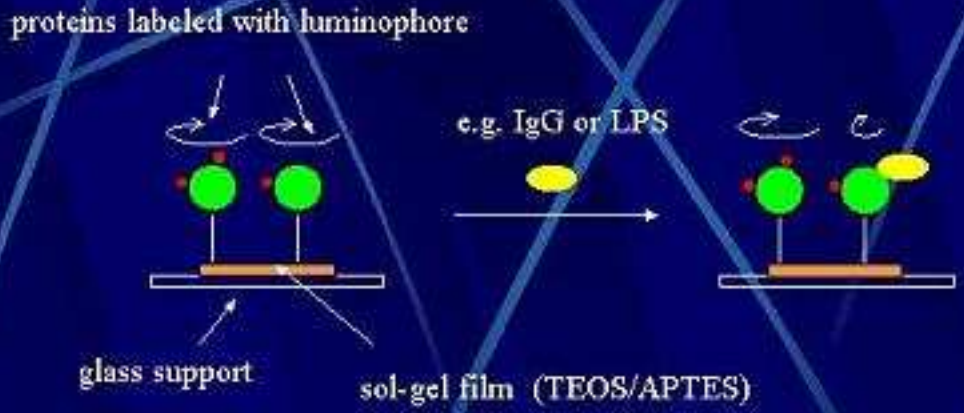


changes of emission intensity with temperature @ 575 nm



Murowski, K., Andrzejewski, D., Strąk, W. *J. Luminesc.* 1997, (72-74), 226

biological sensors based on emission polarization anizotropy measurements



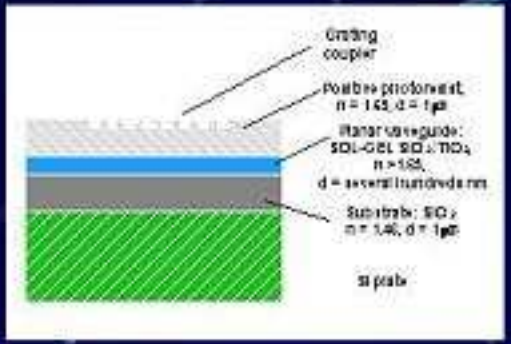
ConA-FITC/LPS

LPS(μg/ml)	Δr
20	11 x

ConA-FITC/Hafnia alvei

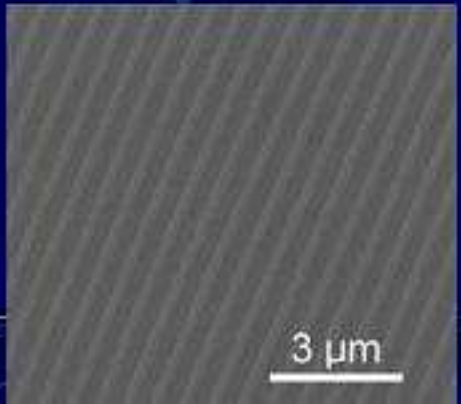
bact. conc.	Δr
4×10^6 bact./ml	27 %

coupling of light to (sol-gel) thin films

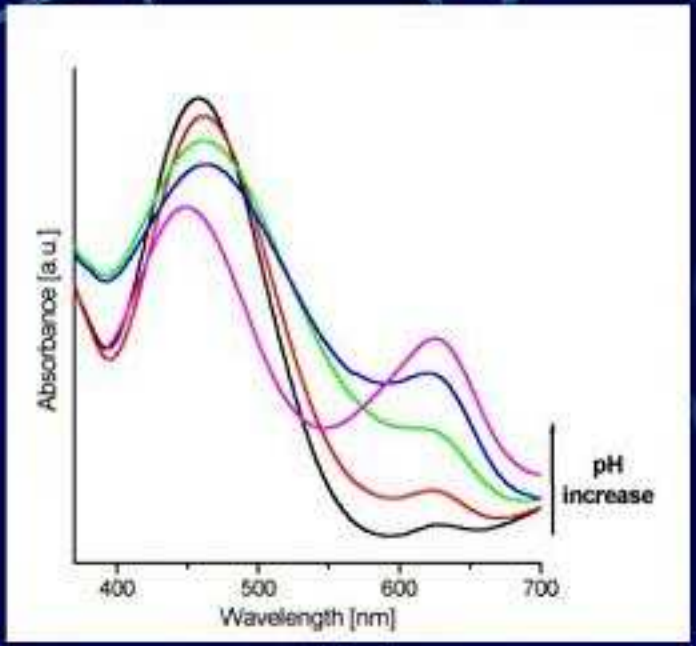


cross-section of TiO_2-SiO_2 planar waveguide with grating coupler fabricated in photoresist remaining on thin film

SEM micrograph of the tilted (70°) top view of grating coupler fabricated in positive photoresist coated on sol-gel planar waveguide. Grating period is estimated to be 640 nm

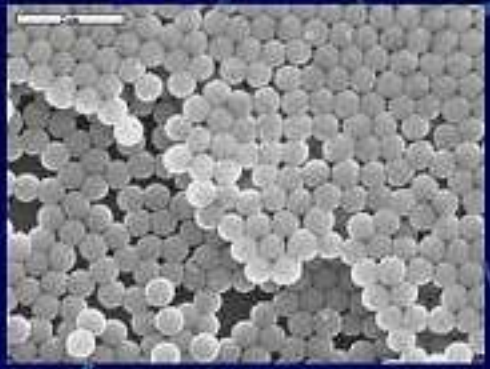


thin-film optode of pH

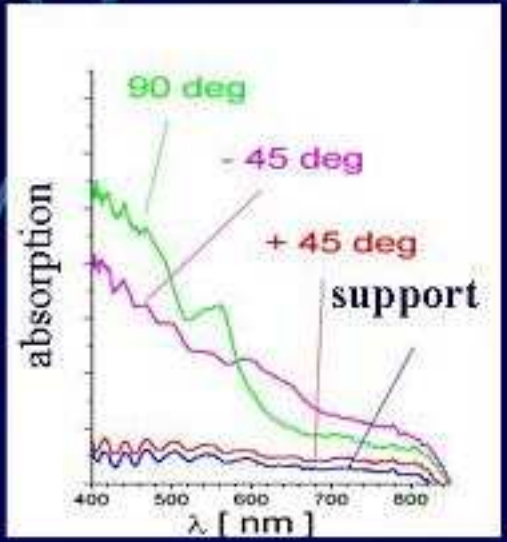


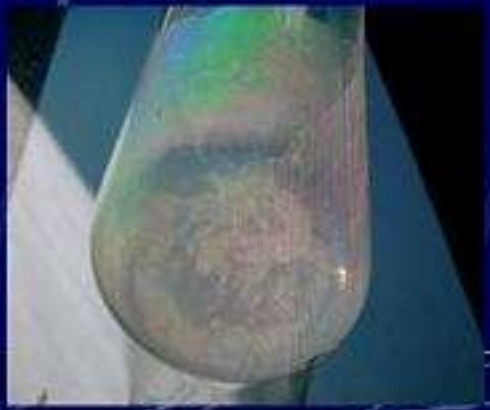
changes in absorption spectrum of SiO_2-TiO_2 (1:1) thin film doped with bromothymol blue caused by pH increase.

silica nanopowder (SEM 10000x)



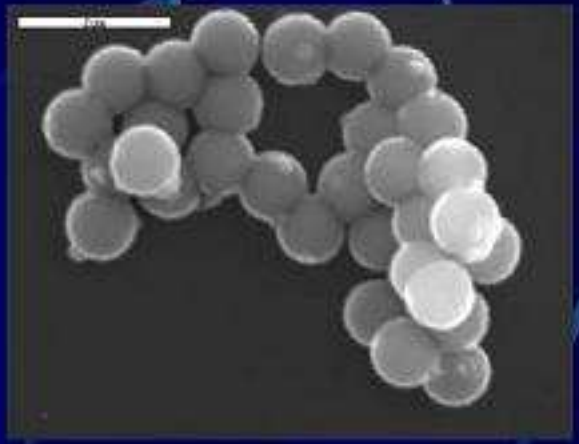
photonic materials





absorption spectra of nanospheres films registered at different angles

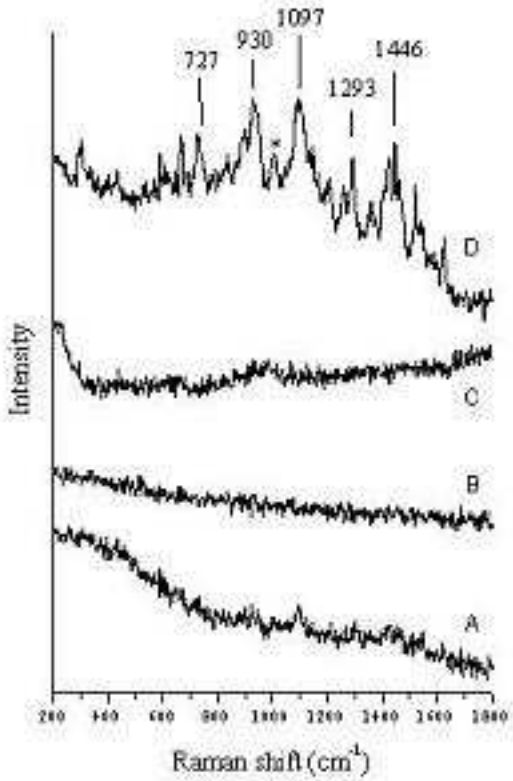
with metallic silver nanoparticles:



SEM

SEM - BEI

FT-Raman spectra of:



Ag-doped silica nanospheres impregnated in IG solution

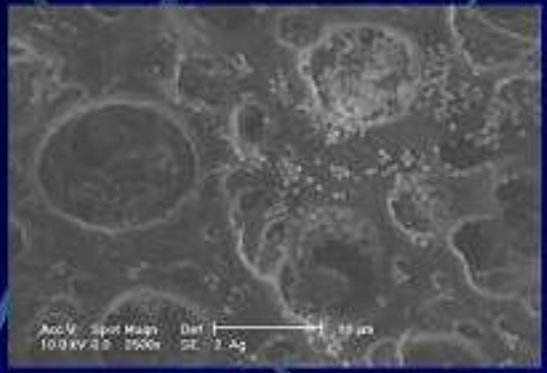
(SERS)

pure Ag-doped silica nanospheres NOT impregnated with IG

Ag-FREE silica nanospheres impregnated in IG solution

IG in aqueous solution

bacteriostatic textiles



(polyurethanes)

S. aureus

Gold Medal at 52nd *Eureka* Fair, Brussels, 2003

confocal microscope pictures of dye-doped silica spheres (∅ ≈ 500 nm)

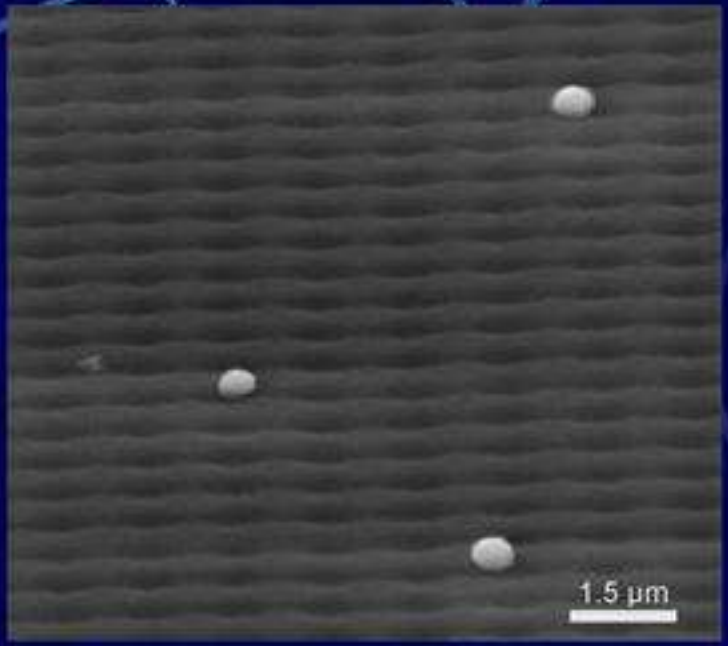
AFM
690 nm x 690 nm

saphranine

rhodamine B

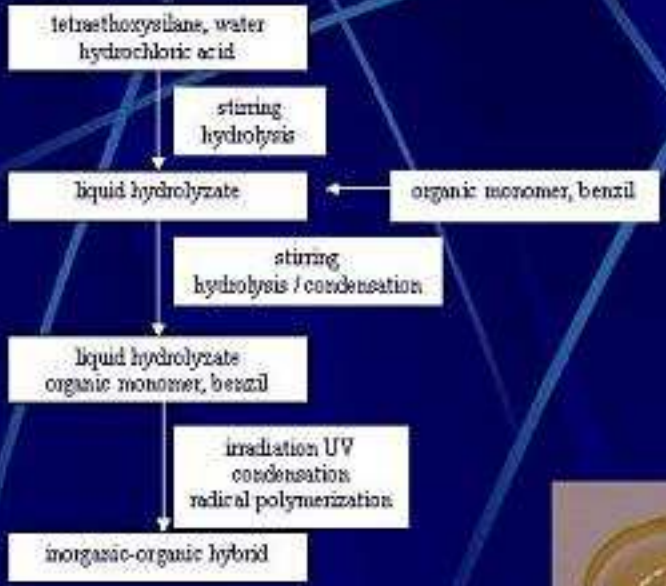
A. Skwarek-Maruszewska unpublished results

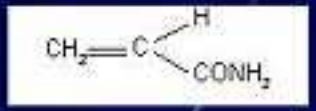
nanochess?



2D photonic crystal in organic photoresists matrix

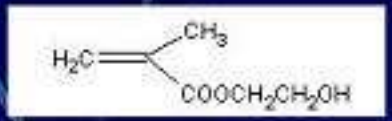
organic-inorganic hybrid materials:



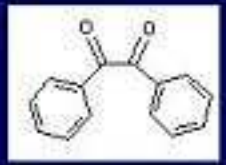


acrylamide

&

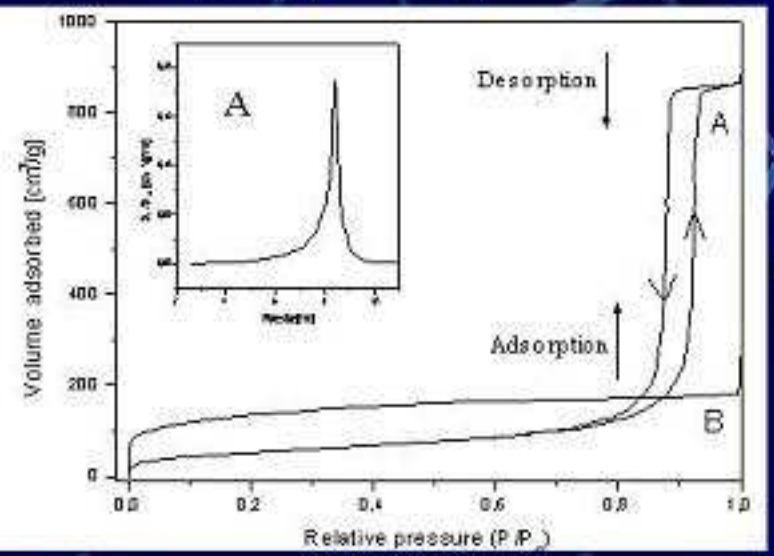


2-hydroxyethylmethacrylate (HEMA)



benzil

N_2 adsorption-desorption isotherms



A – SiO_2 (IUPAC type IV)

B – hybrid (IUPAC type I)

Textural parameters / Sample		S_{BET} [m²/g]	V_p [ml/g]	R_p [nm]	V_{DR} [ml/g]
Silica	A	190	1.32	8.5	-
silica / acrylamide + HEMA		< 1	-	-	-
silica / acrylamide + HEMA (600°C)	B	805*	0.34	< 2	0.29

mesoporous: 2-50 nm

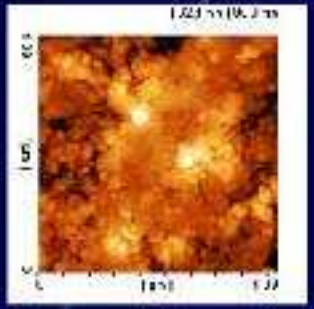
not porous

microporous: < 2 nm

S_{BET} – specific surface area V_p – pore volume R_p – average pore size V_{DR} – micropore volume

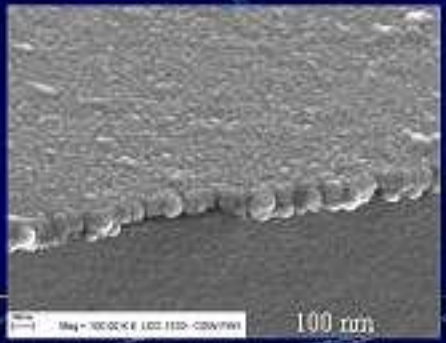
„particulate" films and solids

monolith obtained from APTES
in MeOH



AFM micrographs of a monolith
obtained from APTES and ethylene glycol

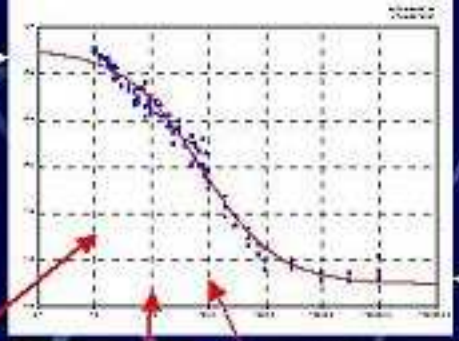
TiO_2 thin films with Ag nanoclusters



(AFM measurements – T. Gotszalk, WUT)

Ballistic Aggregation

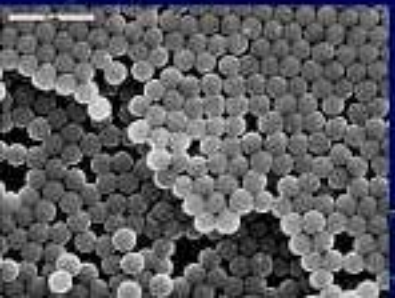
$N(r) = a \cdot r^b$

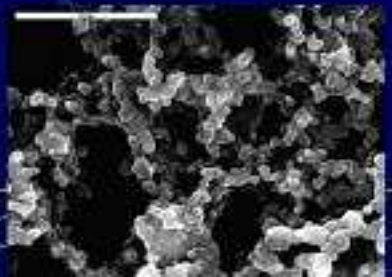


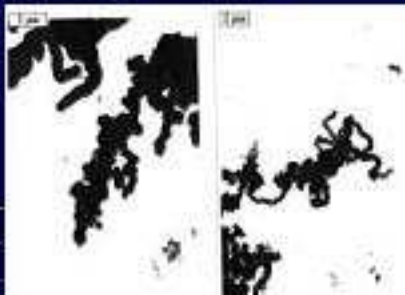
$d_c = 1$

$d_c = 10$

$d_c = 100$







	$d_c = 4,\ \lvert z_{max}\rvert = 10$	$d_c = 4,\ \lvert z_{max}\rvert = 20$	$d_c = 10,\ \lvert z_{max}\rvert = 100$
0°			
45°			
90°			

co-workers:

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