Solid sorbents derived from natural kaolinite and rice husk for the removal of pollutants from water and gas phase

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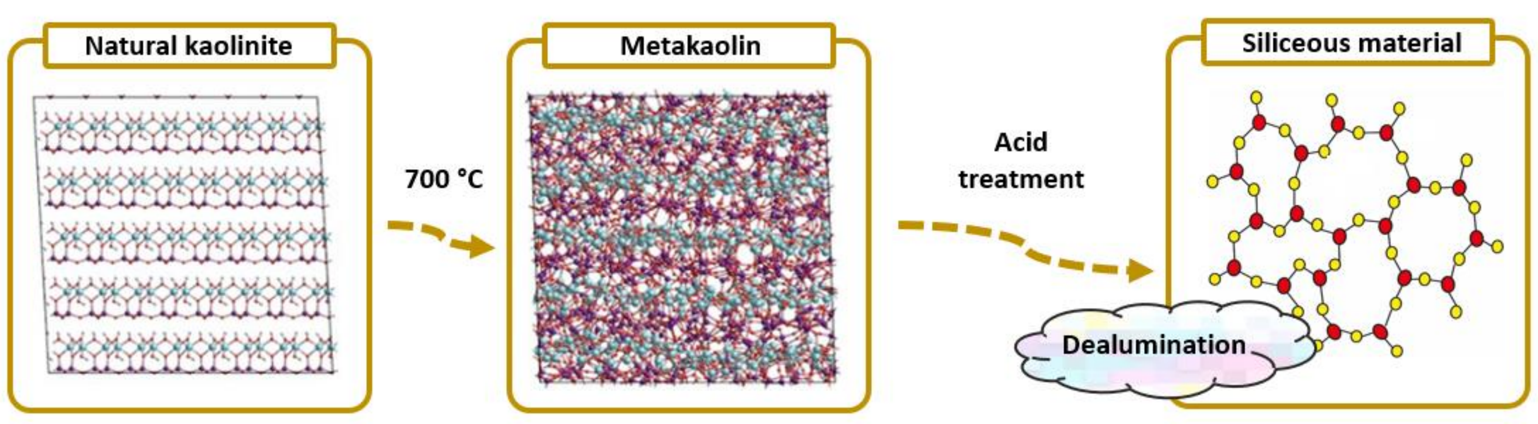
Abstract

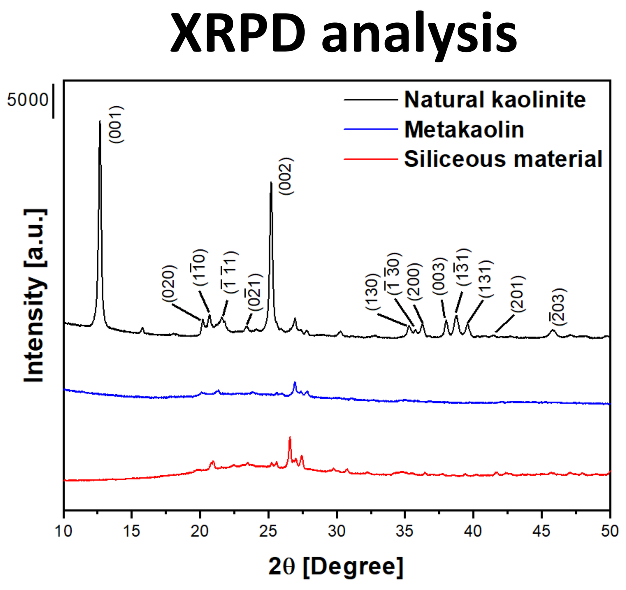
The development of cost-effective sorbents for the capture of pollutants from water and gas phase represent an important and challenging task [1]. Nowadays, as well as performances, a particular attention is also given to the environmental impact of the adsorbents [2]. The tendency has become to employ natural and cheap resources or wastes as precursors to prepare adsorbent materials [2]. In this respect, this work deals with the synthesis of two different solid sorbents from natural and cheap precursors, that were used for the capture of pollutants from both water and gas phase. In detail, a siliceous material was obtained through thermal and chemical modification of natural kaolinite, while a nanometric mesoporous silica was synthesized from biogenic silica contained in rice husk. The physico-chemical properties of the materials were investigated with several techniques including XRPD, MAS-NMR, SEM-EDX, FT-IR and N2 physisorption at 77K. Then, to test their adsorption capacity, both siliceous material and mesoporous silica were used for the removal of Rhodamine B from aqueous phase and toluene from gas phase. The Rhodamine B adsorption processes were studied over time through UV-Vis. spectroscopy, as well as FT-IR spectroscopy was employed to investigate the toluene adsorption processes from gas phase.

Siliceous material derived from natural kaolinite

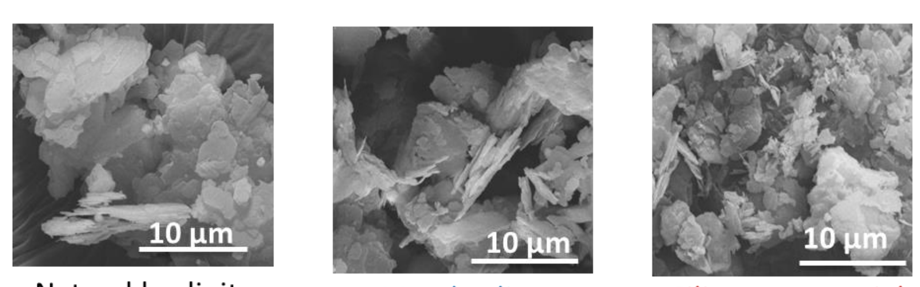


Physico-chemical properties of siliceous material

XRPD analysis



SEM micrographs

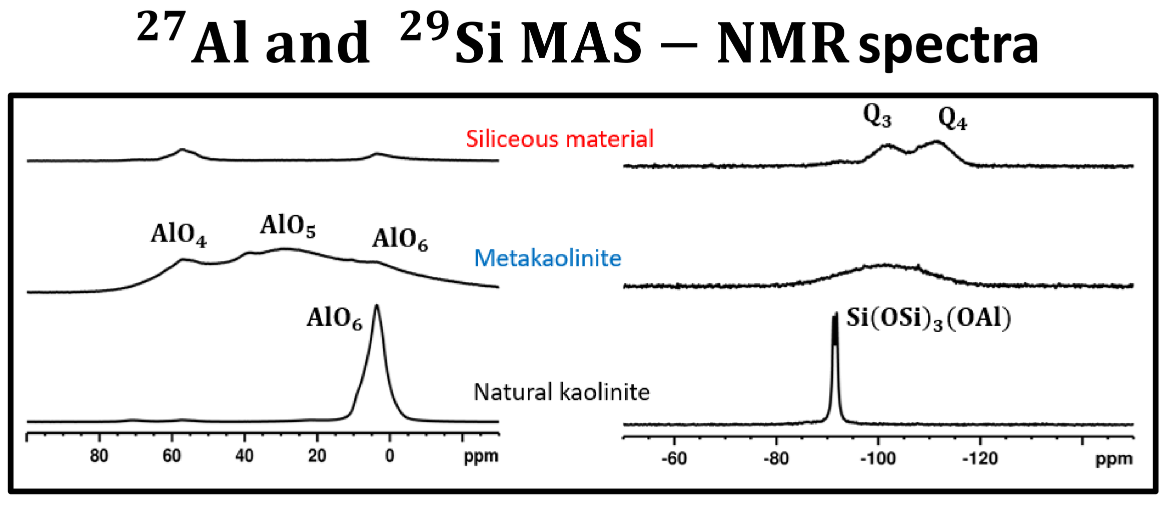


Natural kaolinite Metakaolin Siliceous material

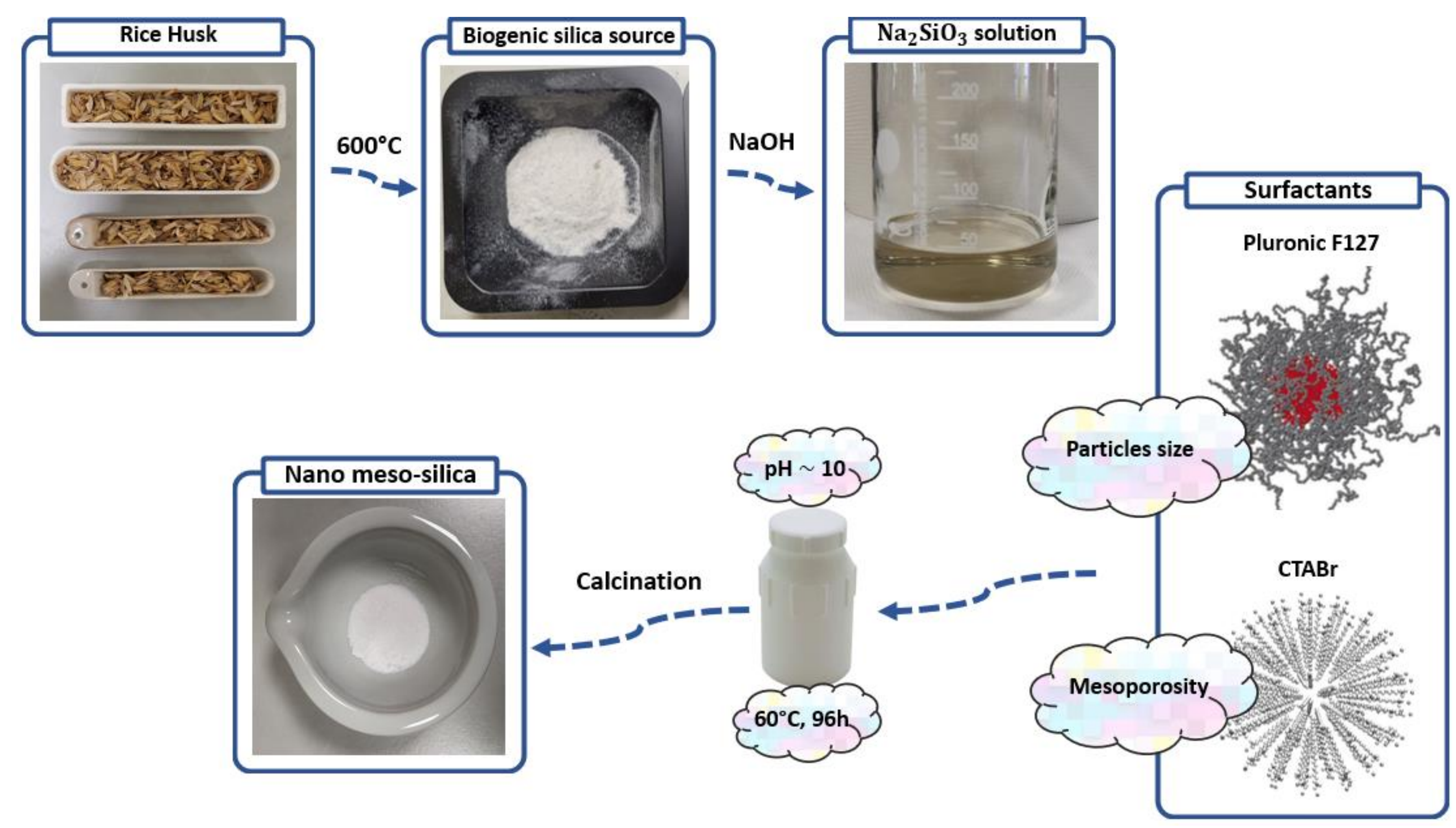
Textural properties

	SSA_{BET} [$m^2 \cdot g^{-1}$]	Pore volume [$cc \cdot Å^{-1} \cdot g^{-1}$]	
		V micro [< 20 Å]	V meso [20 - 500 Å]
Natural kaolinite	9	/	/
Siliceous material	219	0.06	0.13

^{27}Al and ^{29}Si MAS – NMR spectra

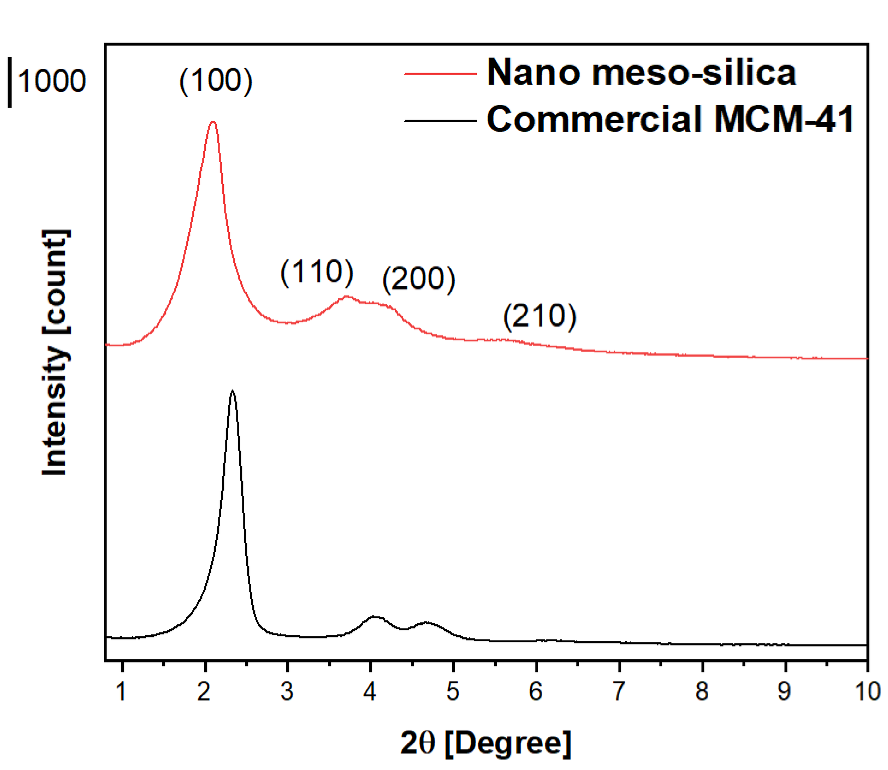


Nanometric mesoporous silica from rice husk

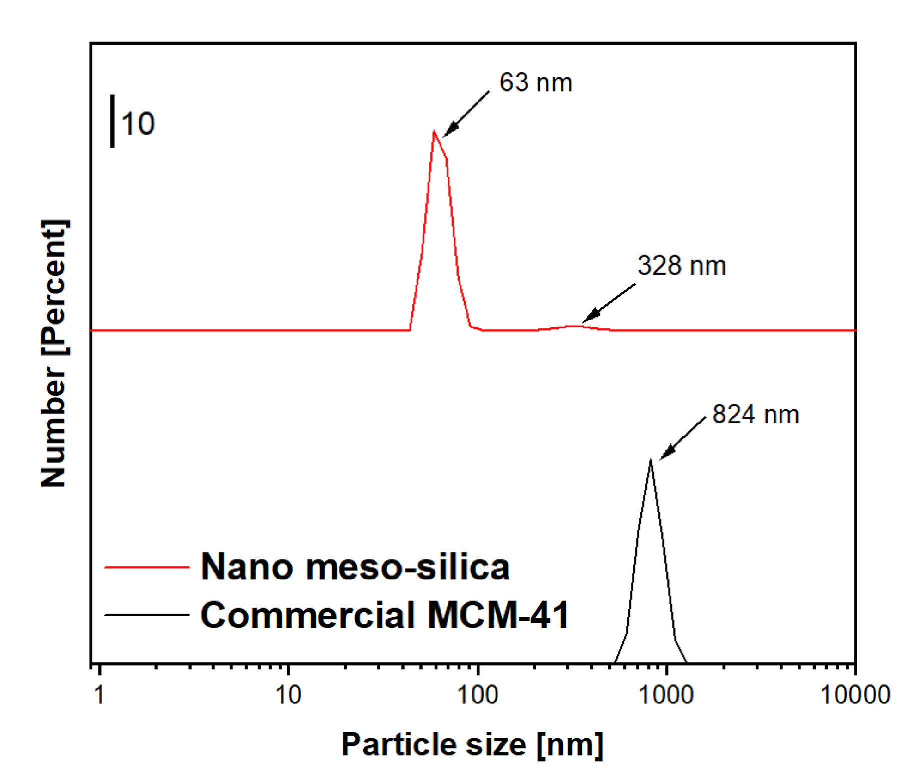


Physico-chemical properties of nanometric mesoporous silica

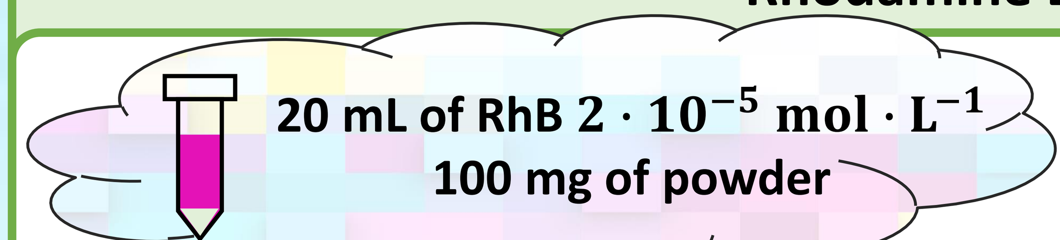
XRPD analysis



DLS analysis in water

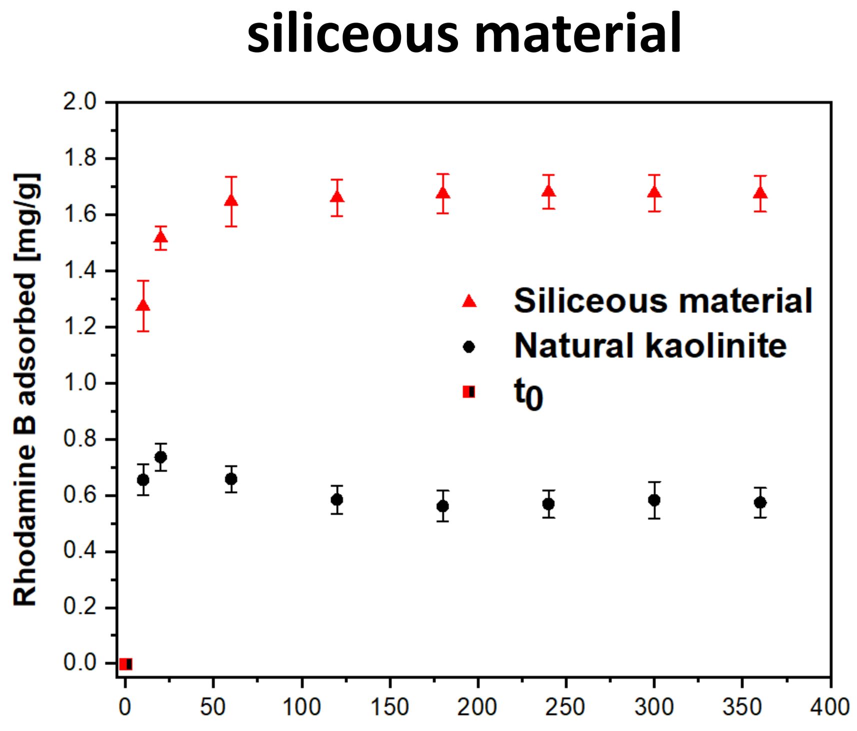


Rhodamine B adsorption from aqueous phase and toluene adsorption from gas phase

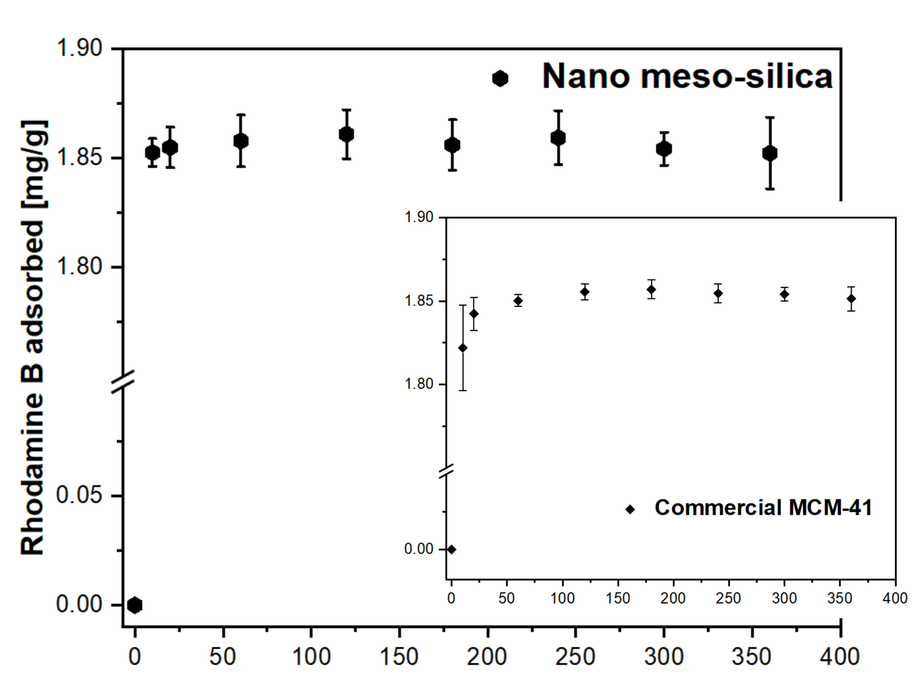


* RhB adsortption data were obetained from UV-Vis. spectroscopy measurements

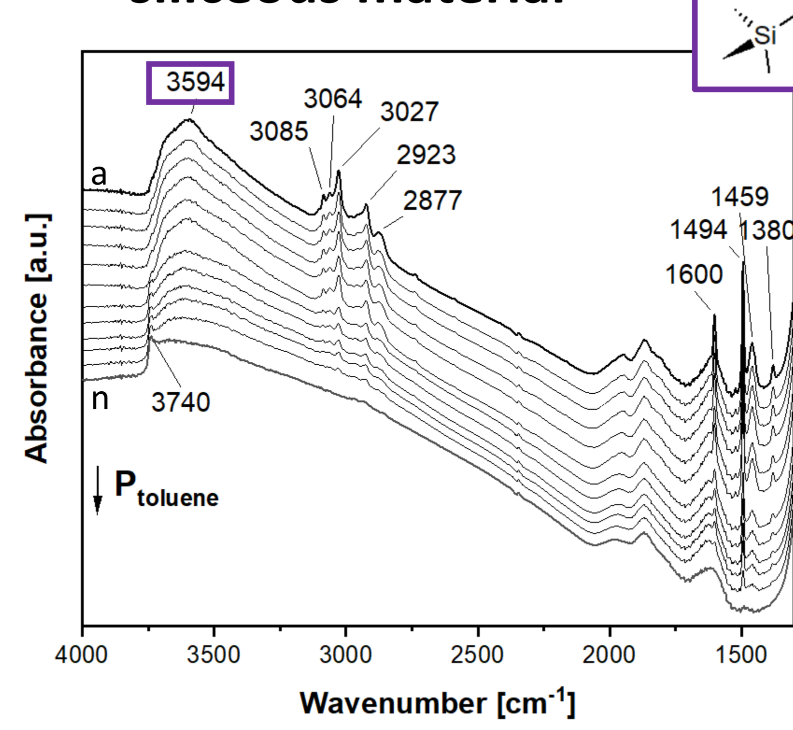
RhB adsorption on siliceous material

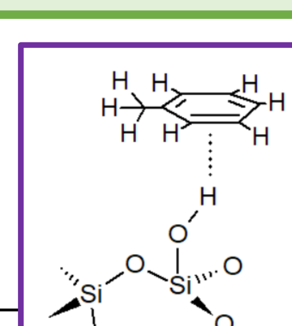


RhB adsorption on nano meso-silica

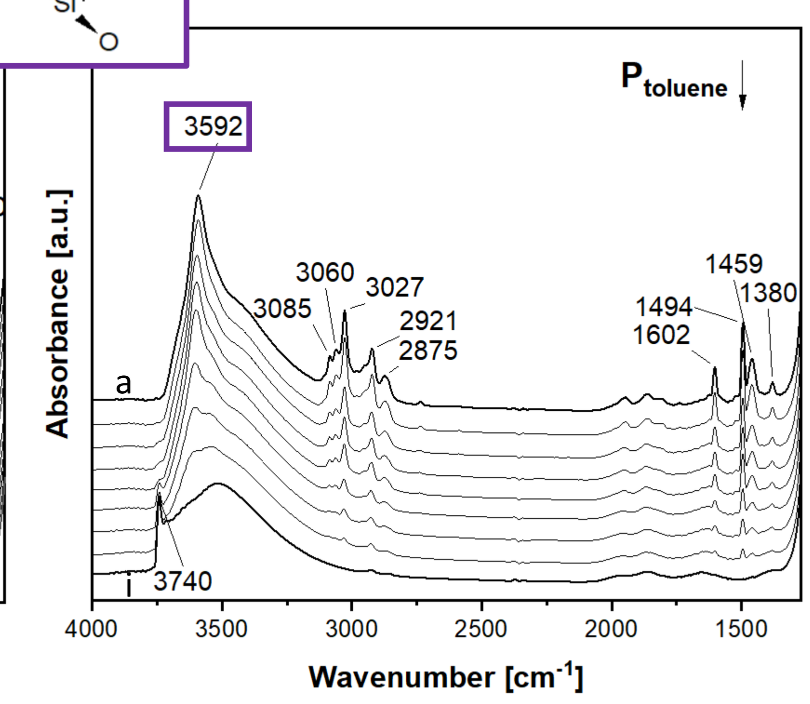


Toluene adsorption on siliceous material





Toluene adsorption on nano meso-silica



* FT-IR spectra were collected after the progressive desorption of 30 mbar of toluene (a), since the complete desorption of the adsorbate (n, i)

References

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[2] G. Celoria et al. Processes (2022), 946
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[4] S. Sperinck et al. J. Mater. Chem. (2011), 21, 2118-2125