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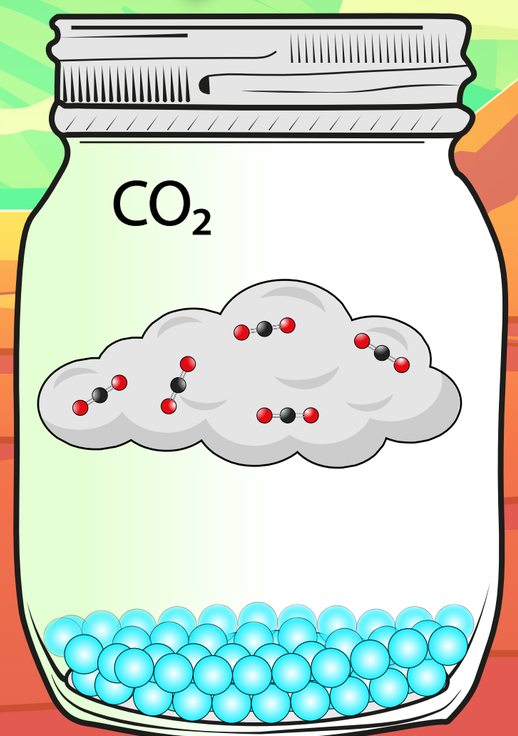
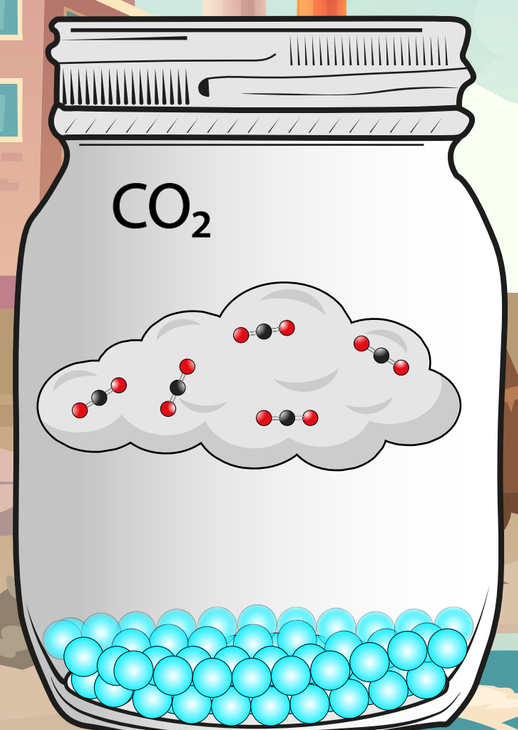
CO_2 ADSORPTION CAPACITIES IN AMINE-FUNCTIONALIZED MICROPOROUS SILICA NANOPARTICLES (SiO_2NPs)





E. J. Cueto Díaz, F. Suárez-García, S. Gálvez-Martínez, M. P. Valles González, E. Mateo-Martí

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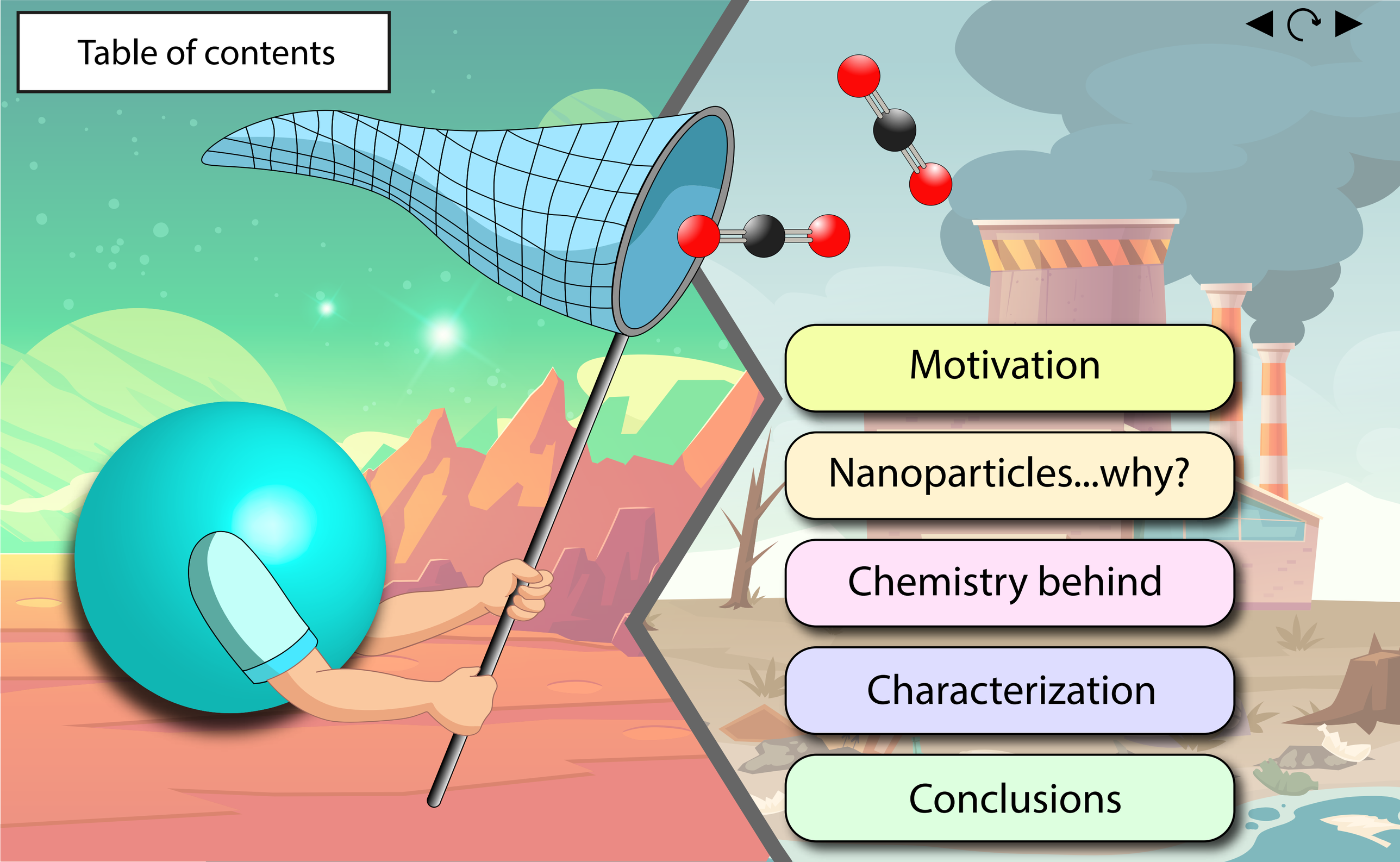
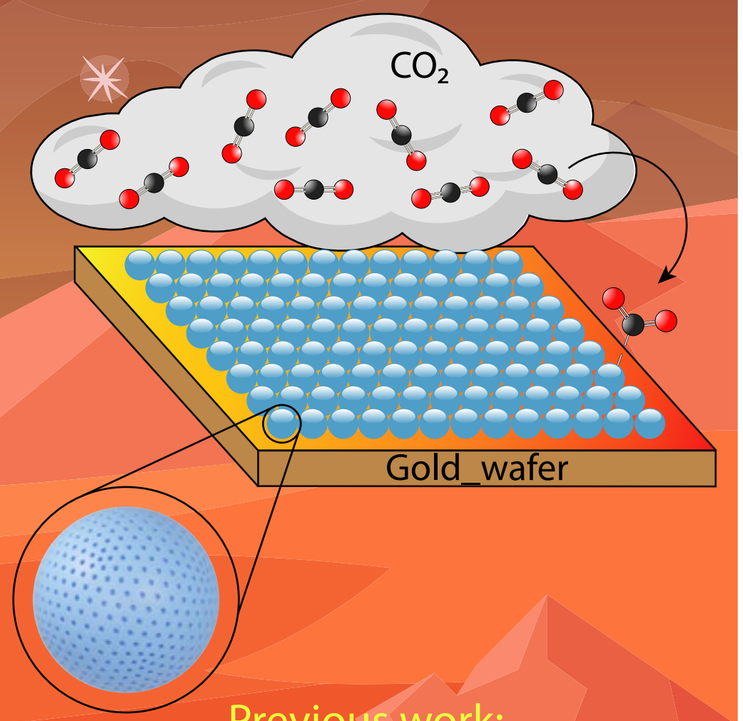


Motivation

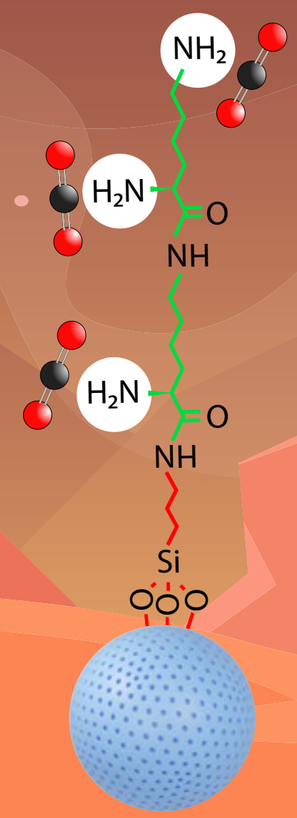
CO_2 sensing



Previous work:
RSC Adv., 2020, 10, 31758-31764

Bare SiO_2NPs for CO_2 sensing

CO_2 capture

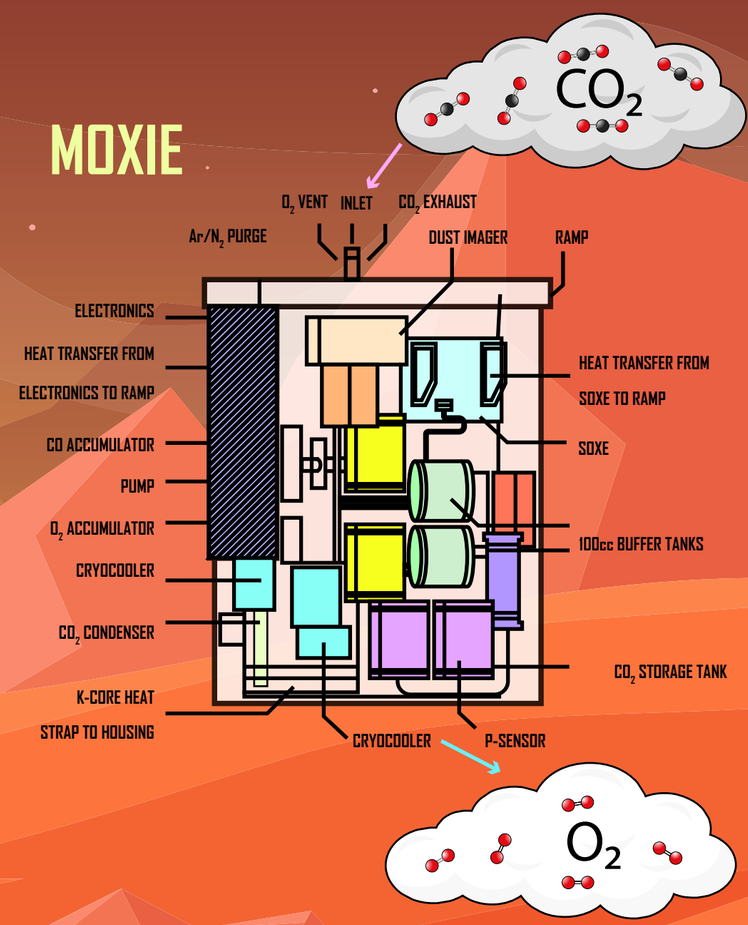


Present study:

SiO_2 functionalization

??

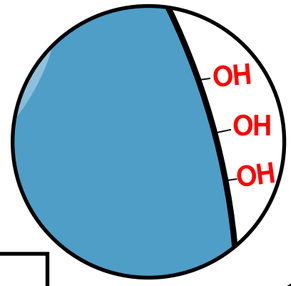
CO_2 capture + O_2 conversion



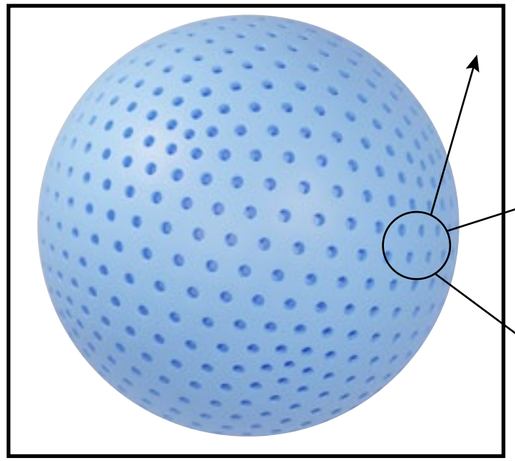
Potential application

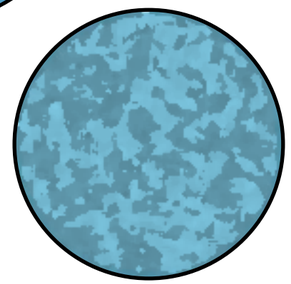
Catalytic properties of SiO_2NPs based nanomaterials for O_2 generation

Nanoparticles...why?

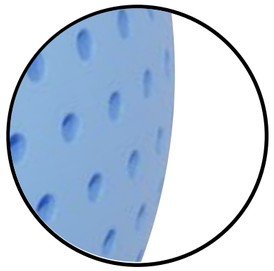


1. OH groups → Deposition/Easy Functionalization





2. Porosity → Catalytic properties: potential conversion CO_2 -> O_2



3. Surface Area → Calculated by BET isotherms

4. Size (200 nm) → At nanoscale, the properties of materials change due to quantum confinement effect.

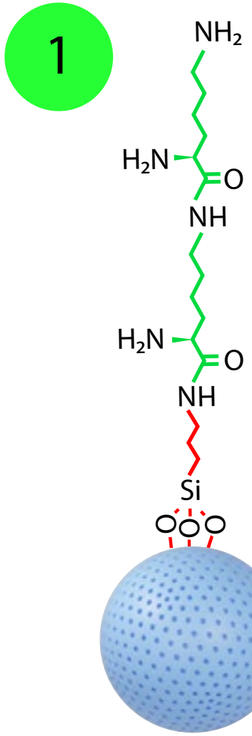
Chemistry behind

$$R\text{-}NH_2 \xrightarrow{CO_2} R\text{-}NH\text{-}COOH$$

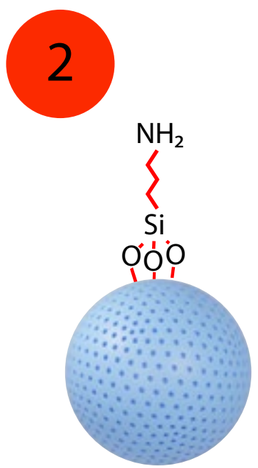
carbamic acid

Affinity towards CO_2

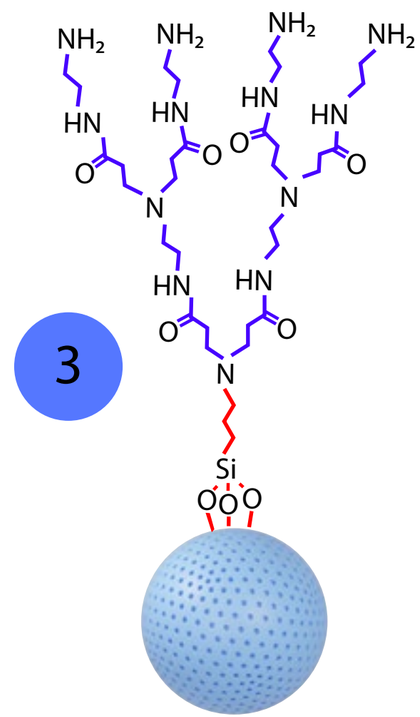
+ ← NH_2 $Si\text{-}(OH)_x$ OH -



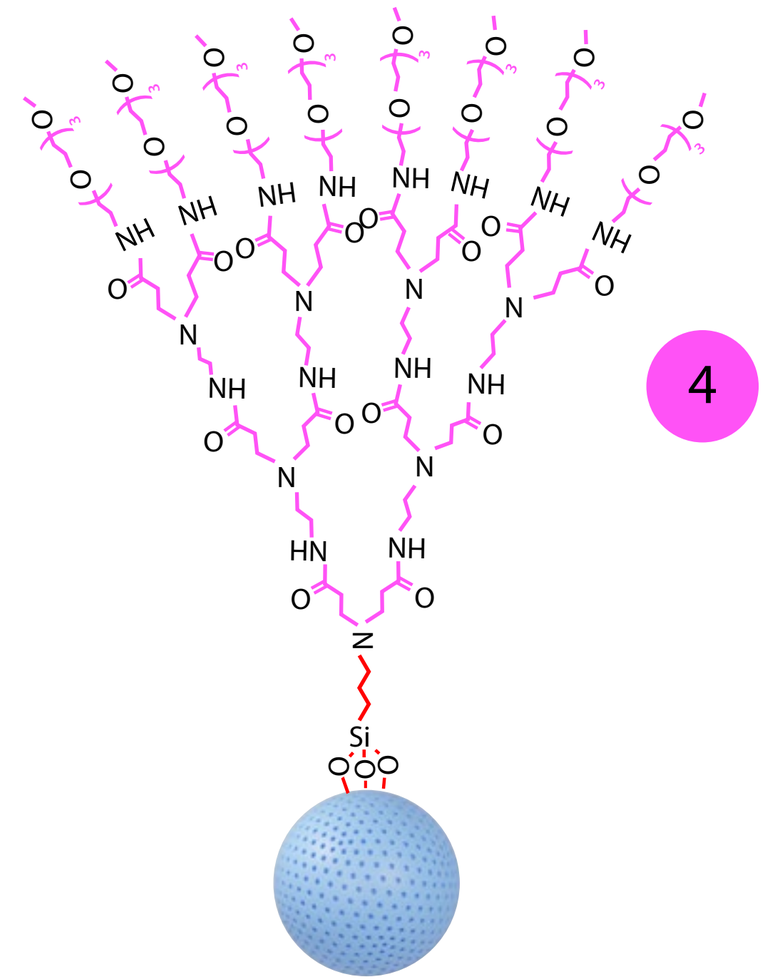
SiO_2@Lys-Lys
(Peptide based)



SiO_2@APTES



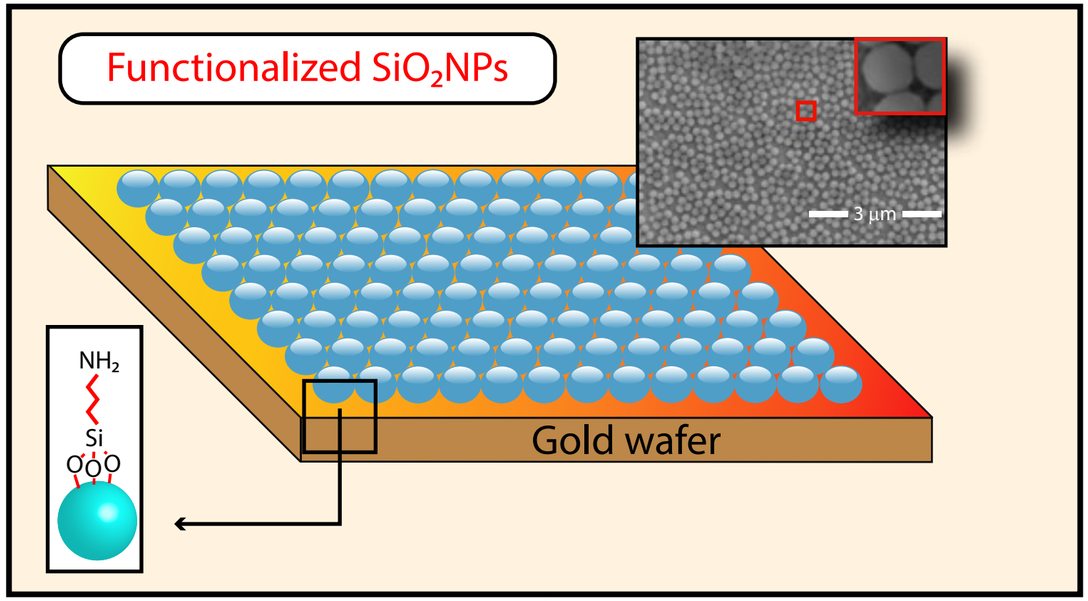
SiO_2@PAMAM
(Dendrimer based)

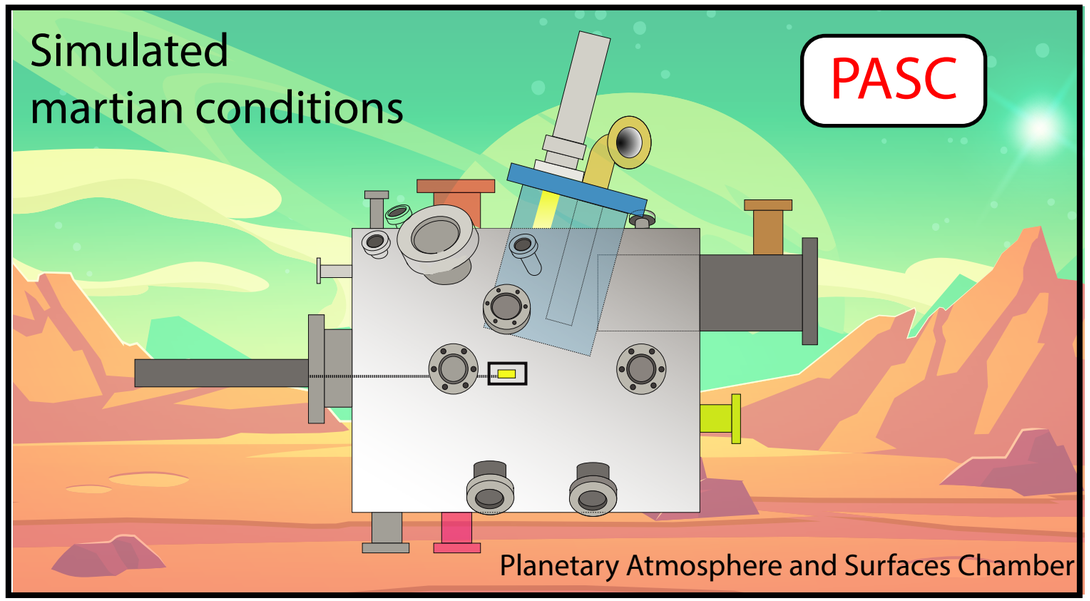


SiO_2@PAMAM(G_3)
(Extended dendrimer based)

Characterization

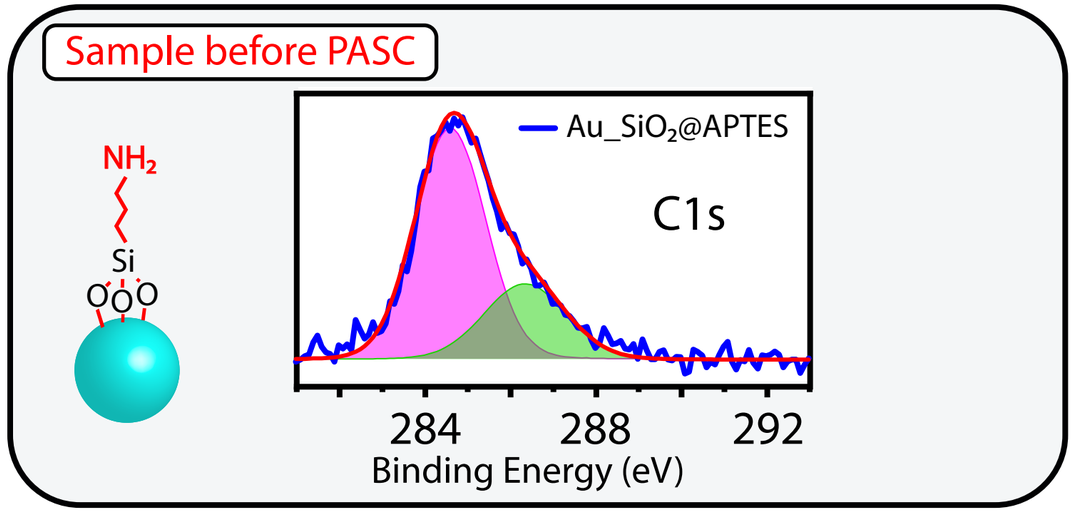
X-Ray photoelectron spectroscopy experiments

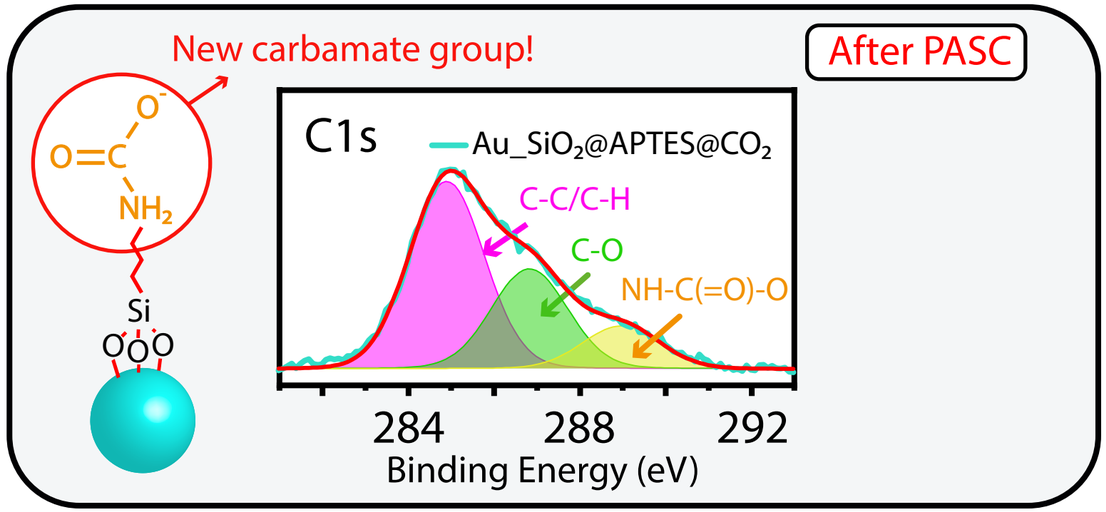




+ ~~O_2~~

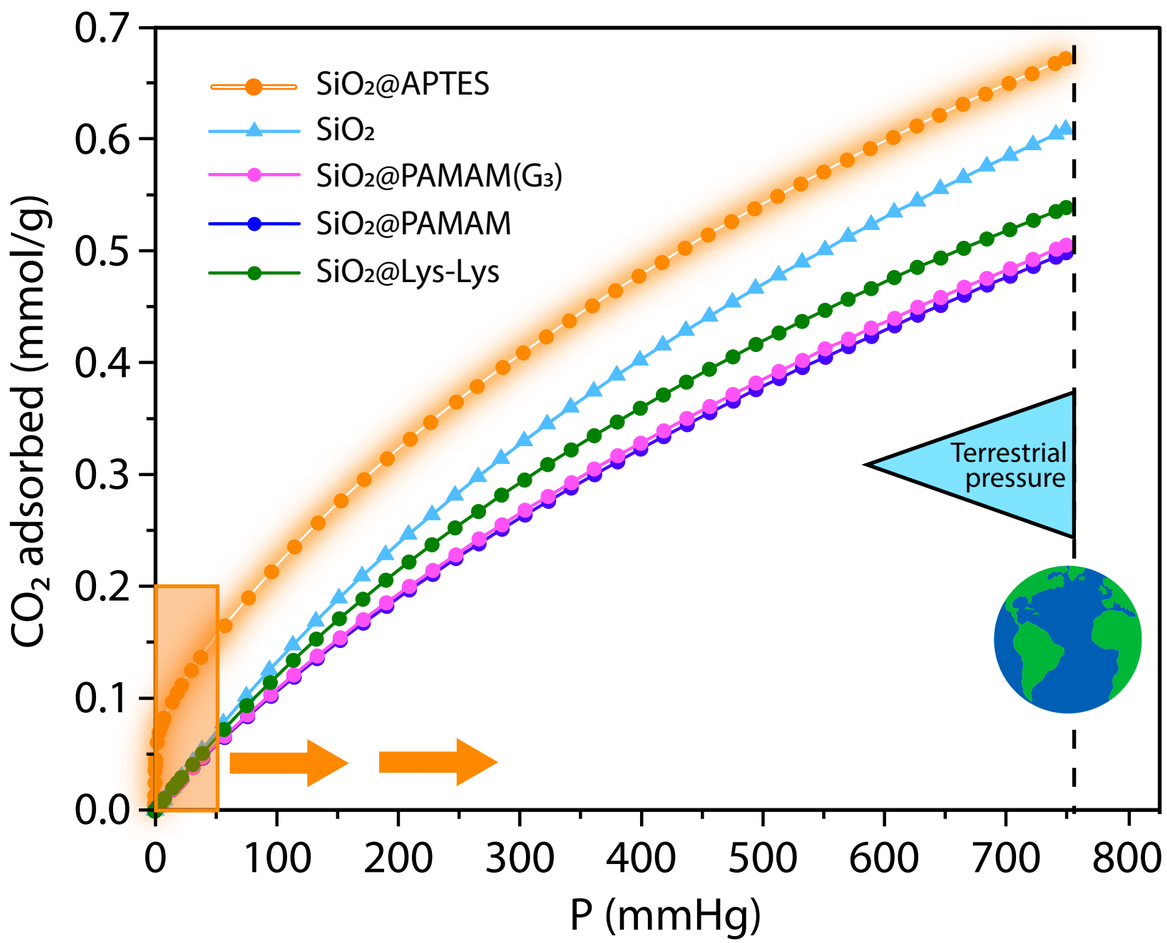
+ CO_2

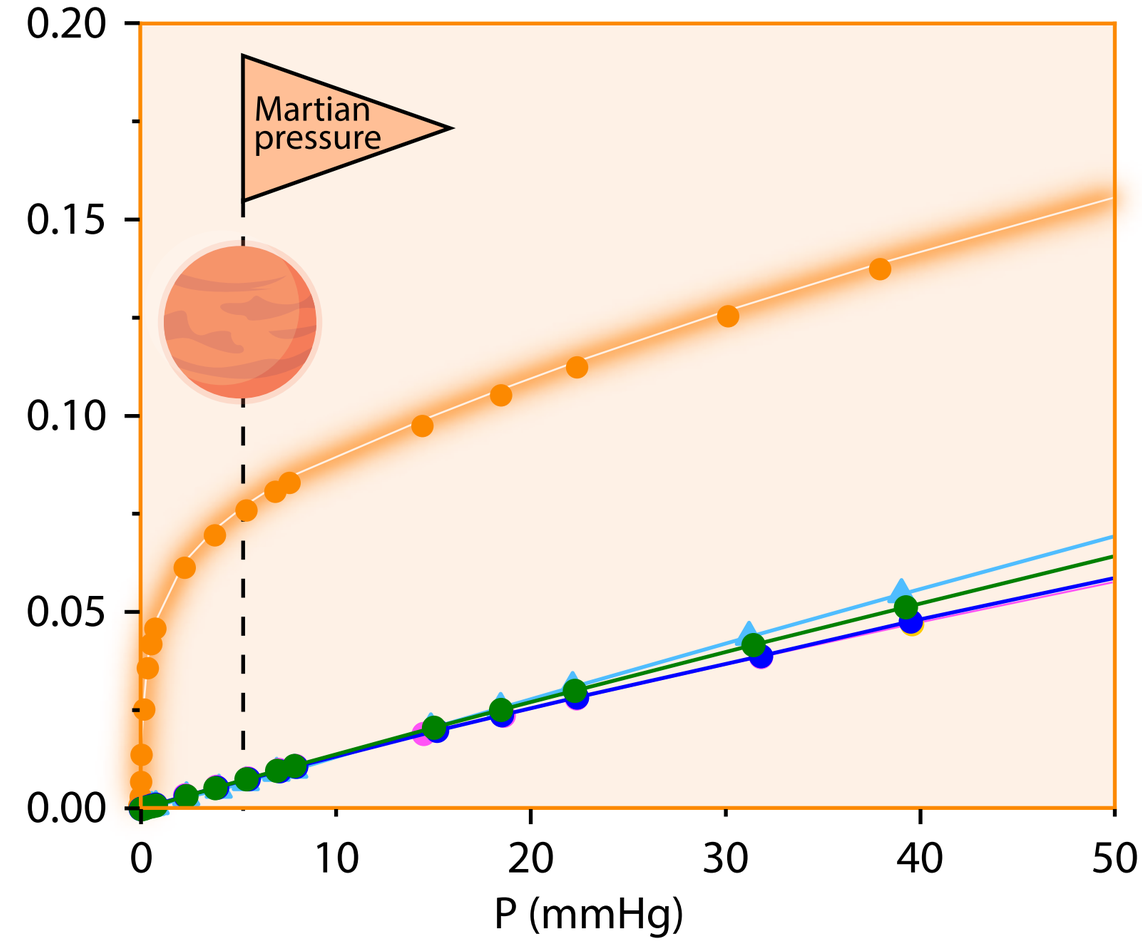




Characterization

CO_2 isotherms at 25 - 50ºC





- CO_2 adsorption isotherms at 25ºC of the 5 samples.
- SiO_2@APTES overpass bare SiO_2NP CO_2 ads. capacities and the other hybrid nanomaterials

- (inset) Martian pressure range
- APTES based nanoparticles increases CO_2 retention at Martian pressures

Conclusions

- Amine functionalized non-mesoporous SiO_2NPs have been produced
- SiO_2NPs@APTES showed the greatest CO_2 sorption capacities
- Carbamate formation was assessed by XPS techniques
- Surprisingly, the hiper-branched dendritic SiO_2NPs displayed lower affinity towards CO_2, probably either as a steric hindrance or interaction between the surface of the SiO_2NP and the ligand itself
- These nanomaterials could be used as potential platforms for catalytic reactions, i.e. conversion of CO_2 into O_2 (Ru aided) in future planetary exploration