

Novel functionalized nanomaterials for CO₂ capture

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Novel functionalized nanomaterials for CO₂ capture. Credit: Copyright Royal Society of Chemistry (RSC). Polshettiwar et al. *Chemical Science*, 2012, 3, 2224-2229

Climate change due to excessive CO₂ levels is one of the most serious problems mankind has ever faced. This has resulted in abrupt weather patterns such as flood and drought, which are extremely disruptive and detrimental to life, as we have been witnessing in India in recent years. Mitigating rising CO₂ levels is of prime importance. In a new development, scientists at the Tata Institute of Fundamental Research, Mumbai, have developed a novel design of CO₂ sorbents that show superior CO₂ capture capacity and stability over conventional materials.

The immobilization of functional amines on a porous solid support can result in stable and efficient CO₂ sorbent [materials](#) compared to similar liquid sorbents. A critical disadvantage however, is a drastic decrease in the textural properties of these supports (i.e., their surface area and pore volume), leading to a decrease in the CO₂ capture capability.

To overcome this challenge, scientists at TIFR Mumbai, have designed novel functionalised nanomaterials that allows higher amine loading with a minimal decrease in surface area.

"Our fibrous nanosilica (KCC-1) should be a good candidate for use as a support to design efficient CO₂ sorbents that would allow better capture capacity, kinetics and recyclability", says Dr Vivek Polshettiwar, the lead scientist of this study. A unique feature of KCC-1 is its [high surface area](#), which originates from its fibrous morphology and not from its mesoporous channels (unlike in other well studied materials like SBA-15 or MCM-41). This study, published recently in the *Journal of Materials Chemistry A*, demonstrates the usefulness of the fibrous morphology of KCC-1 compared to conventional ordered mesoporous silica. This work is in continuation of the teams efforts to develop sustainable catalysts and sorbents.

The KCC-1-based sorbents showed several advantages over conventional silica-based sorbents, including i) high amine loading, ii) minimum

reduction in surface area after functionalization and iii) more accessibility of the amine sites to enhance CO₂ capture efficiency (i.e., capture capacity, kinetics and recyclability), due to the fibrous structure and high accessible surface area of KCC-1.

The demand for such efficient sorbents is on the rise since CO₂ capture is one of the best solutions to mitigate the rising levels of CO₂. Solid sorbents exhibit better efficiency with greater potential to overcome the shortcomings of liquid sorbents. The use of mesoporous silica materials functionalized with various amino groups is well reported. Although materials like SBA-15 and MCM-41, for example, have attracted significant attention because their large pore sizes can accommodate a variety of amine molecules and the high [surface area](#) allows for a higher loading of these functional molecules, they suffer from the disadvantages of a decrease in textural properties, thus making KCC-1 a suitable candidate for more efficient CO₂ capture.

More information: Baljeet Singh et al, Design of CO₂ sorbents using functionalized fibrous nanosilica (KCC-1): insights into the effect of the silica morphology (KCC-1 vs. MCM-41), *J. Mater. Chem. A* (2016).
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