Carbon dioxide sequestration using bio-renewable materials

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The increased worldwide anthropogenic greenhouse gases emissions especially carbon dioxide (CO_2) is believed to be the main cause of global warming phenomenon, which is expected to cause severe environmental problems such as rising sea levels, droughts, oceans acidification as well as extinction of many plants and animals.

To cope with the continued increase in the worldwide energy demands, huge efforts are being made to reduce the dependence on fossil fuels throughout exploiting renewable energy resources, however, the inherent limitations of the fossil fuels based economies hinder the reduction of CO_2 emissions to safe levels. In this respect, carbon capture and sequestration (CCS) was introduced to address the increased build-up in the atmospheric CO_2. Currently, different materials have been implemented to achieve CSS through exploiting wet scrubbing, solid sorbents, and membranes.

Following the seventh principle of green chemistry, ***"renewables for renewables approach"*** offers an eco-friendly platform to capture CO_2 using renewable, inedible feedstocks to promote future development benefiting from their environmental and economic impacts over petroleum-based feedstocks. In this regard, chitin (the second most naturally-occurring polymer) and its derivative chitosan are strong candidates that might serve as sorbents. Herein, we reported on CO_2 fixation through the formation of novel organic carbonato–carbamato motif by oligochitosan as well as on the "supramolecular chemisorption" of CO_2 by the oligomeric chitin acetate dissolved in dimethyl sulfoxide (DMSO).

The formation of the sequestered species were confirmed using 1D and 2D nuclear magnetic resonance spectroscopy together with the ex situ and in situ attenuated total reflectance-Fourier transform Infrared spectroscopy, and verified using density functional theory (DFT) calculations. The CO_2 sorption capacity of the explored materials showed promising values among other sorbents reported in the literature. One of the major concerns regarding the greenness of DMSO was answered by measuring the biodegradability of the explored system.

References

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