Synthesis and Characterization of Porous Polymer-based Adsorbents for CO_2 Capture

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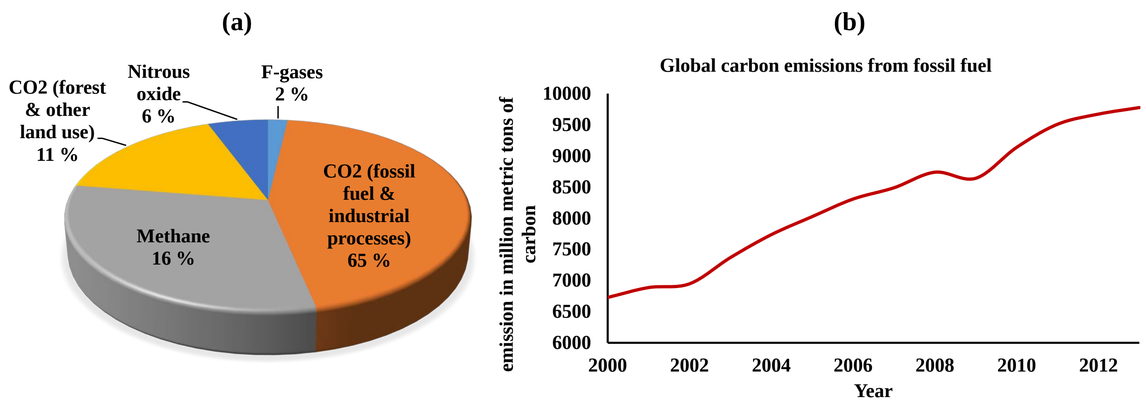
Introduction

Combustion of fossil fuels for energy and transport is highly responsible for CO_2 emission, a major greenhouse gas contributing to an increasing global warming. Carbon capture and storage (CCS) has been regarded as the best approach to reduce CO_2 released into the atmosphere. Various CCS technologies include: physical absorption, chemical absorption, adsorption, membrane separation; however, each of these technologies has its own inherent limitations such as high equipment corrosion rate, high energy requirement, poor selectivity, operational limitation, toxicity and environmental unfriendly. In this work, a Porous Polymeric Material (PPM) with CO_2 -philic NH_2 groups from non-toxic, inexpensive and readily available materials was synthesized and its CO_2 adsorption capacity was investigated.



(a) Global greenhouse gas emissions in 2010 (b) Global carbon emissions from fossil fuel

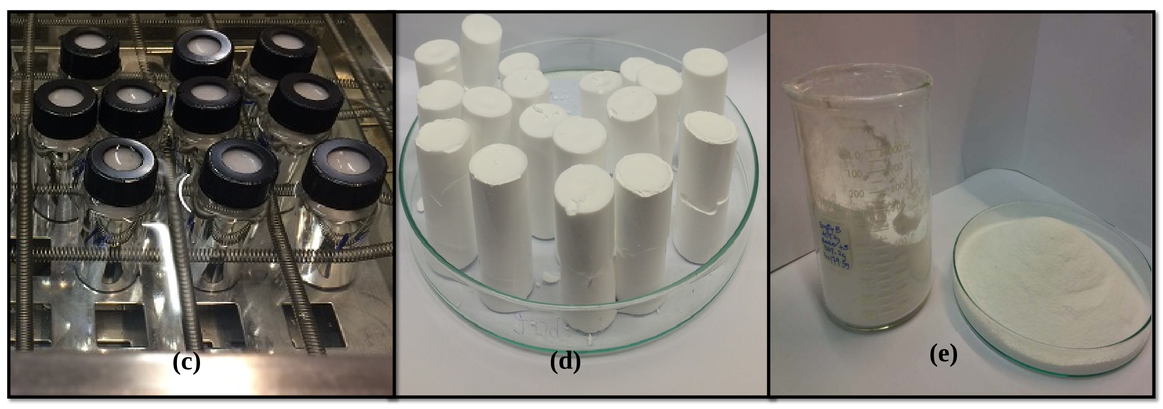
Methodology

Materials

- Methacrylamide (MAAM) – Functional monomer
- Ethylene glycol dimethacrylate (EGDMA) - crosslinker
- Azobisisobutyronitrile (AIBN) – iniator
- Acetonitrile – porogent
- Methanol - solvent

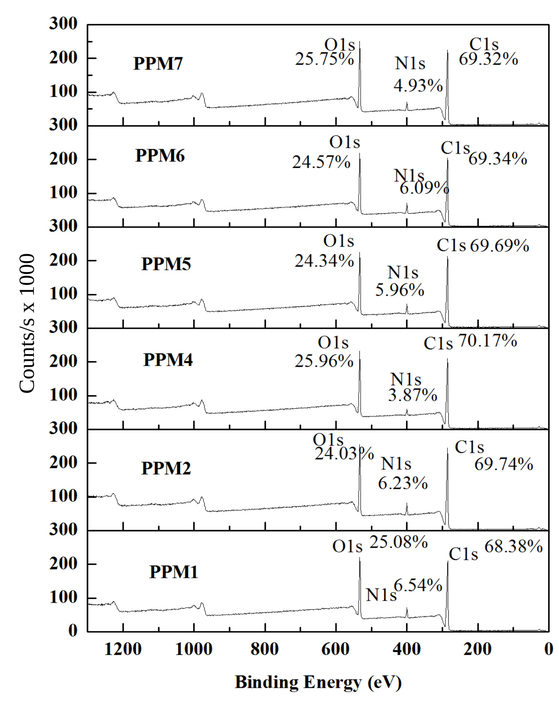
Experimental

MAAM was dissolved in AN followed by adding EGDMA and AIBN. The mixture was degasses and purged with N_2, then sealed up and placed in closed water bath (60 ^{0}C) for 24 h. The resultant bulk polymer particles were ground and screened to 90-212 µm, washed with methanol, and dried overnight in a vacuum oven (60 ^{0}C).

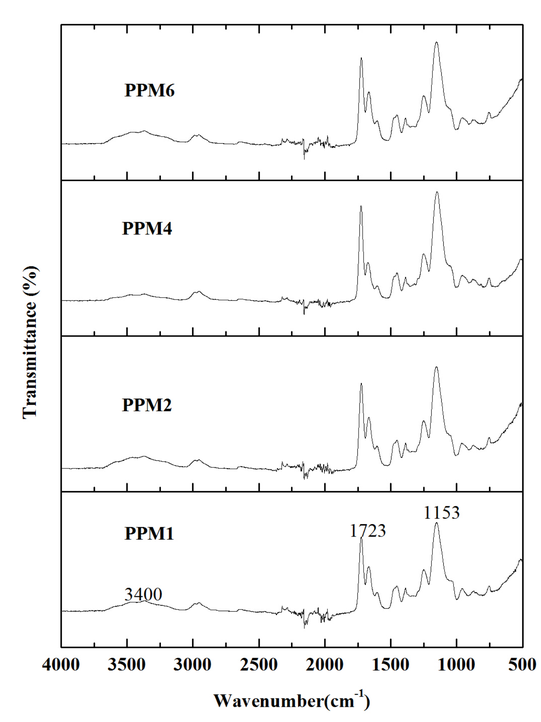


(c) Prepared mixture placed in water bath **(d)** the bulk sample after polymerization **(e)** the final product after grinding, sieving and drying

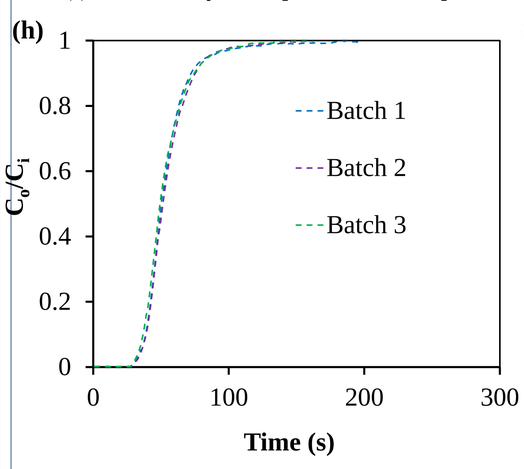
Experimental results



(f) XPS survey Al K photoelectron spectra of PPM.

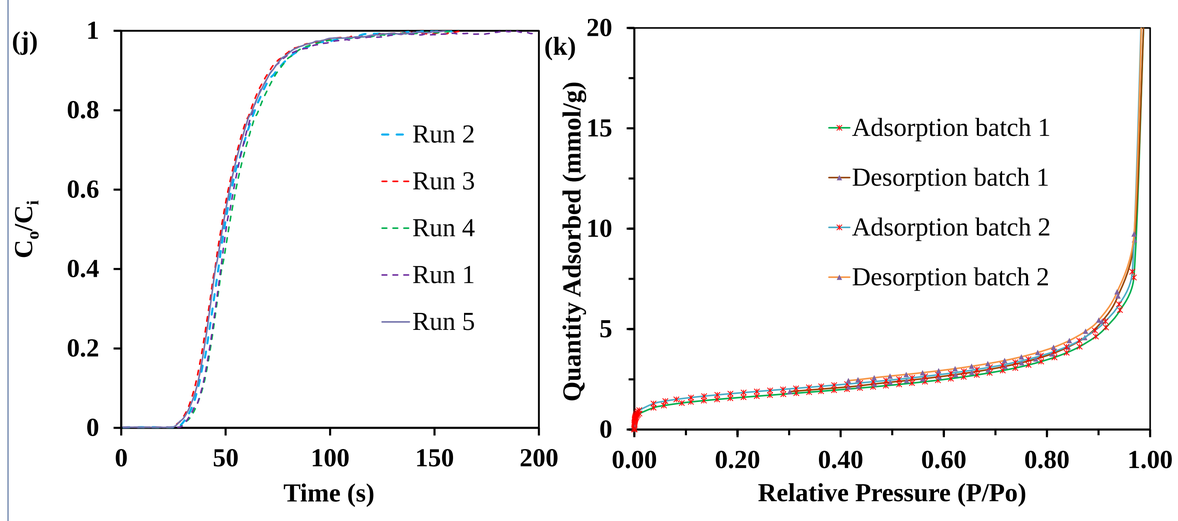


(g) FTIR spectra of PPMs.



(h) Reproducibilty test based on of PPMs.

(i) SEM images of polymer PPM particles



(j) Re-usability test based on of PPMs.

(k) Nitrogen adsorption/desorption isotherms measured at 77 K.

Conclusions

- A series of simple, inexpensive, non-toxic and environmental friendly PPM was developed for CO_2 adsorption with a promising CO_2 capture capacity.
- The adsorbents retained its -NH_2 functional group of the based monomer and also, the C=C of the monomer, MAAM and cross-linker, EGDMA were completely broken as confirmed in the XPS and FTIR analysis.
- All the adsorption isotherms of PPMs as shown exhibit a typical shape of type II featuring a non-uniform distribution of pore size.
- The PPM exhibited CO_2 uptake capacity up to 0.64 mmol/g at 313 K and 0.15 bar CO_2 partial pressure and consistent in both reusability and reproducibility test run.

References

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[4] Nabavi, S. A.; Vladisavljević, G. T.; Eguagie, E. M.; Li, B.; Georgiadou, S.; Manović, V. Production of Spherical Mesoporous Molecularly Imprinted Polymer Particles Containing Tunable Amine Decorated Nanocavities with CO_2 Molecule Recognition Properties. Chem. Eng. J. 2016, 306, 214–225.