Summary

~~In a first aspect, t~~There is provided a polymer material comprising mesopores extending between melamine-formaldehyde co-polymer nano-particles and wherein micropores extend within the co-polymer nano-particles.

In a first aspect, there is provided a polymer material comprising mesopores disposed between melamine-formaldehyde co-polymer nano-particles and wherein micropores extend within the co-polymer nano-particles, wherein the melamine-formaldehyde co-polymer is composed of repeating units of a monomer having a ring structure.

The combination of the mesopores and micropores results in a very melamine-formaldehyde co-polymer with a very high surface area. The disclosed polymer material exhibits a high surface area, a well-defined pore structure and a high density of amine functional groups. Advantageously, owing to its high surface area, the disclosed polymer has been found to exhibit a high rate of CO_2 adsorption and desorption. Furthermore, the amine functional groups of the melamine units can form weakly-binding bonds with CO_2 molecules (having low bond energies between 15-26 kJ/mol). Advantageously, the disclosed polymer material can be regenerated easily as the adsorbed CO_2 gas can be readily desorbed and then purged from the polymer material, for example, by flushing with an inert gas. Furthermore, the disclosed polymer material is composed of readily available and inexpensive raw materials, i.e., melamine and formaldehyde. Therefore, the disclosed polymer material is cost-effective to produce and can be used as a CO_2 gas absorption agent and to provide an alternative to existing liquid CO_2 scrubbers. At the same time, the disclosed polymer material overcomes the technical

drawbacks of existing solid sorbents which exhibit low surface areas for adsorption and which require complex synthesis procedures.

In one embodiment, the polymer material may comprise a surface area of at least 300 m^2/g. In another embodiment, the polymer material may possess a surface

area of at least 600 m^2/g. In yet another embodiment, the polymer material may possess a surface area in a range of from 600 m^2/g to 1,200 m^2/g. Advantageously, the large surface area is provided by the combination of the mesopores which extend between an agglomerated mass of melamine-formaldehyde co-polymer nano-particles and the micropores which extend within the melamine-formaldehyde co-polymer nano-particles themselves. The large surface area allows the polymer material to adsorb larger quantities of gaseous compounds relative to known polymer materials of melamine-formaldehyde co-polymer nano-particles and further improves the rate and extent of gas absorption. For example, the disclosed polymer material may be used as an adsorbent material in the fabrication of a solid gas scrubber for processing high throughput waste gases containing high concentrations of carbon dioxide.

In a second aspect, there is provided a sorbent material for adsorbing gas comprising the polymer material as described above.

~~In a third aspect, t~~There is provided a sorbent material for adsorbing gas comprising an agglomeration of melamine-formaldehyde co-polymer nano-particles with mesopores extending between said nano-particles and wherein micropores extend within the nano-particles.

In a third aspect, there is provided a sorbent material for adsorbing gas comprising an agglomeration of melamine-formaldehyde co-polymer nano-particles with mesopores extending between said nano-particles and micropores extending within the nano-particles, and wherein the melamine-formaldehyde co-polymer is composed of repeating units of monomers having a ring structure.

Advantageously, the formation of micropores vastly increases the available surface area for the sorbent

material to contact and adsorb the gas onto the surface of the polymer material. Further advantageously, the mesopores caused by the agglomeration of melamine-formaldehyde copolymer nanoparticles increase the overall porosity of the polymer material, thereby allowing gases to freely flow through the polymer material with minimal or negligible pressure drop across the polymer material.

In a fourth aspect, there is provided the use of the polymer material as claimed in the first aspect to adsorb a gas. In one embodiment, the gas may be carbon dioxide. In another embodiment, the gas may be carbon monoxide.

In a fifth aspect, there is provided a method of removing at least one of carbon dioxide gas and carbon monoxide gas from a gas stream containing said at least one of carbon dioxide gas and carbon monoxide gas, the method comprising the step of contacting the gas stream with a polymer material as defined in the first aspect above to adsorb at least one of said carbon dioxide gas and carbon monoxide gas thereon.

~~In a sixth aspect, t~~There is provided a method of making a polymer material comprising the step of reacting melamine with formaldehyde in the presence of a non-aqueous polar solvent.

In a sixth aspect, there is provided a method of making a melamine formaldehyde co-polymer comprising the step of reacting melamine with formaldehyde in the presence of a non-aqueous polar aprotic solvent.

Advantageously, the non-aqueous polar solvent is selected so that the reactant mixture of melamine and formaldehyde are soluble therein. As the melamine and formaldehyde react they form the resulting copolymer (hereafter "PMF polymer") is insoluble or has very poor insolubility in the selected non-aqueous solvent and hence copolymer nanoparticles form that have micropores extending therein. The microporous copolymer nanoparticles then agglomerate and adhere together to form mesopores therebetween. The selection of a non-aqueous solvent renders the resulting PMF polymer significantly more porous and having a higher surface area due to its high porosity relative to PMF that is reacted in a pure aqueous solvent such as water.

However, it should be realized that while the disclosed method reacts melamine and formaldehyde in the presence of a non-aqueous solvent, an aqueous solvent such as water may also be present in the reactants.