3D printable materials for CO2 capture and separation technologies

Abstract

The increasing of the anthropogenic CO_2 emissions have brought, in the last century, to an unacceptable climate change due to the rise of the global temperature. The reduction of CO_2 concentration in the atmosphere has become a crucial aspect to contrast global warming. In this context, different carbon capture (CC) technologies have been developed to directly absorb and separate CO_2 at the source. This thesis describes the study carried out on smart materials able to be processed through DLP 3D printing for CO_2 capture and management. In particular, photo-curable formulations, composed of a photo-crosslinkable monomer and different functional additives, will be described from the preparation to the characterization and application.

The first study describes the work carried out on the preparation of photo-curable resins containing light responsive azo-benzene-based dyes for the control of CO_2 permeability in 3D printed structures. CO_2 Permeability analysis related to light irradiation of membranes containing Poly (ethylene glycol) diacrylate (PEGDA) and two azobenzene dyes, namely Methyl Red (MR) and Disperse Red 1 Methacrylate (DR1M), will be shown. Analysis with oxygen, to evaluate CO_2/O_2 permselectivity, will be also described. Finally, the successful 3D printing of a specific designed device for the control of CO_2 flow by an external laser source will be presented.

The second study aims to investigate the influence of different ionic liquids (ILs) on the printability of photo-curable resins for 3D printing. The goal was to introduce CO_2-philic species (ILs) as additives in liquid formulations and demonstrate the possibility to create solid structures through digital light processing (DLP) technology. The polymerization ability and the comparison of physical and chemical properties of formulations containing PEGDA and ILs with different cations and anions, bearing reactive groups will be presented. Moreover, the successful 3D printing of high complexity structures will be shown.

In the last study, the synthesis of specifically functionalized imidazolium-based ILs able to be integrated in 3D printable photo-curable formulations and absorb CO_2 will be described. Chemical and physical properties of the liquid and photo-cured formulations containing PEGDA and ILs with CO_2-philic anions and

cations will be shown. Finally, high pressure CO_2 absorption analysis of the 3D printed structures containing the active ILs will be presented.