

SINTESIS Mg@ZIF-67 UNTUK KONVERSI CO₂ MENJADI KARBONAT SIKLIK: STUDI VARIASI MASSA KO-KATALIS TBAB

Ratna Meida Nur Isyada
22/492604/PA/21126

INTISARI

Penelitian mengenai sintesis dan karakterisasi *Zeolitic Imidazolate Frameworks-67* (ZIF-67) terdoping Mg (Mg@ZIF-67), aplikasinya sebagai katalis dalam reaksi fiksasi CO₂, serta pengaruh variasi massa *tetrabutylammonium bromide* (TBAB) sebagai ko-katalis dalam reaksi fiksasi CO₂ telah dilakukan. Penelitian ini bertujuan untuk mempelajari metode sintesis dan mengkaji struktur serta morfologi material Mg@ZIF-67, mengevaluasi kinerja katalitik Mg@ZIF-67 dalam reaksi fiksasi CO₂ menjadi karbonat siklik, serta mempelajari pengaruh variasi massa TBAB sebagai ko-katalis dalam reaksi konversi CO₂ menjadi karbonat siklik. Material Mg@ZIF-67 disintesis melalui metode sederhana dengan mencampurkan larutan prekursor kobalt(II) nitrat heksahidrat (Co(NO₃)₂·6H₂O) dan magnesium(II) nitrat heksahidrat (Mg(NO₃)₂·6H₂O) serta ligan 2-metilimidazol yang dilarutkan dalam pelarut metanol. Rasio molar Co(NO₃)₂·6H₂O dengan Mg(NO₃)₂·6H₂O yang digunakan yaitu 2:0,875 dan 2:1,5 (Co:Mg). Material yang telah disintesis dikarakterisasi dengan XRD, FTIR, FE SEM-EDX, TEM, DTA-TGA, dan SAA-BET. Reaksi fiksasi CO₂ dengan katalis Mg@ZIF-67 dan ko-katalis TBAB dilakukan dalam sistem tertutup dengan tekanan gas CO₂ sebesar 7 bar, suhu 80°C selama 6 jam dengan reaktan epiklorohidrin dan gas CO₂ sehingga diperoleh produk berupa senyawa klorometil etilen karbonat.

Hasil penelitian menunjukkan keberhasilan sintesis material Mg@ZIF-67 untuk kedua variasi molar. Berdasarkan hasil analisis, kristal yang diperoleh berbentuk dodekahedron dengan dominasi ukuran diameter permukaan yaitu pada kisaran 600-700 nm untuk variasi 0,875 mmol dan 500-600 nm untuk variasi 1,5 mmol. Uji ¹H-NMR menunjukkan persen konversi CO₂ menjadi karbonat siklik dengan variasi massa TBAB 0, 5, 10, 15, dan 20 mg TBAB secara berurutan yaitu 42,92; 62,89; 70,42; 81,97; dan 97,09% yang mengindikasikan bahwa efisiensi reaksi fiksasi CO₂ meningkat seiring bertambahnya TBAB yang digunakan sebagai ko-katalis.

Kata kunci: metal-organic frameworks, fiksasi CO₂, Mg@ZIF-67, TBAB

SYNTHESIS OF Mg@ZIF-67 FOR CO₂ CONVERSION INTO CYCLIC CARBONATES: A STUDY ON TBAB CO-CATALYST MASS VARIATION

Ratna Meida Nur Isyada
22/492604/PA/21126

ABSTRACT

The synthesis and characterization of *Zeolitic Imidazolate Frameworks-67* (ZIF-67) doped by Mg (Mg@ZIF-67), its application as catalyst in CO₂ fixation, and study of the effect of *tetrabutylammonium bromide* (TBAB) mass variation as co-catalyst in CO₂ fixation reaction have been conducted. This study aims to examine the synthesis method and to analyze the morphology of Mg@ZIF-67 materials, to evaluate its potential as catalyst in CO₂ fixation reaction and to examine the mass variation of TBAB as co-catalyst in the conversion CO₂ into cyclic carbonates. The Mg@ZIF-67 material was synthesized using a simple method by mixing precursor solutions of cobalt(II) nitrate hexahydrate (Co(NO₃)₂·6H₂O) and magnesium(II) nitrate hexahydrate (Mg(NO₃)₂·6H₂O) with 2-methylimidazole ligand that were dissolved in methanol. The molar ratios of Co(NO₃)₂·6H₂O to Mg(NO₃)₂·6H₂O used were 2:0.875 and 2:1.5 (Co:Mg). The Mg@ZIF-67 materials were characterized using XRD, FTIR, FE-SEM-EDX, DTA-TGA, and SAA-BET. The CO₂ fixation reaction using Mg@ZIF-67 as a catalyst and TBAB as a co-catalyst was carried out in a closed high-pressure system at 7 bar, temperature of 80 °C for 6 hours using epichlorohydrin and CO₂ gas, producing chloromethyl ethylene carbonate compounds.

The results showed the successful synthesis of Mg@ZIF-67 materials for both molar variations. Based on the analysis, the obtained crystals exhibited a dodecahedral morphology with dominant particle size diameters in the range of 600–700 nm for the 0.875 mmol variation and 500–600 nm for the 1.5 mmol variation. The ¹H-NMR analysis showed that the conversion percentages of CO₂ into cyclic carbonate with TBAB mass variations of 0, 5, 10, 15, and 20 mg were 42.92%, 62.89%, 70.42%, 81.97%, and 97.09%, respectively, indicating that the efficiency of the CO₂ fixation reaction increased with increasing TBAB mass used as a co-catalyst.

Keywords: metal-organic frameworks, CO₂ fixation, Mg@ZIF-67, TBAB