

# Sintesis dan karakterisasi NiZn/karbon mesopori sebagai katalis heterogen reaksi karboksilasi asetilena dengan CO<sub>2</sub> = Synthesis and characterization of NiZn/mesoporous carbon as heterogeneous catalyst for carboxylation reaction of acetylene with CO<sub>2</sub>

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## Abstrak

Pemanfaatan bahan bakar fosil, batu bara, minyak, serta gas alam yang kaya akan karbon semakin marak digunakan guna keberlangsungan hidup manusia. Pemanfaatan bahan-bahan tersebut juga turut andil dalam peningkatan konsentrasi CO<sub>2</sub> di atmosfer. Meningkatnya emisi CO<sub>2</sub> menyebabkan turut meningkatnya suhu bumi dan perubahan iklim yang disebabkan oleh 'efek rumah kaca'. Sehingga, konversi CO<sub>2</sub> menjadi senyawa yang lebih bermanfaat sangatlah diperlukan. Dalam penelitian ini, dilakukan sintesis dan karakterisasi karbon mesopori termodifikasi NiZn sebagai katalis heterogen reaksi karboksilasi asetilena dengan CO<sub>2</sub>. Karbon mesopori disintesis dengan metode *soft template* menggunakan surfaktan pluronik F127 sebagai *template* organik, serta *phloroglucinol* sebagai prekursor karbon. Karbon mesopori kemudian dimodifikasi dengan logam nikel dan seng (NiZn/MC) dengan metode deposisi-presipitasi homogen, dilanjutkan dengan reduksi dengan aliran gas H<sub>2</sub> (30 ml per menit) selama 90 menit pada suhu 400 °C. Pola difraksi XRD menunjukkan puncak-puncak pada 2θ sekitar 31,79°; 34,54°; 36,31°; 44,04°; 51,51°; 56,51°; 62,22°; dan 75,68° yang mengindikasikan terdapatnya spesi NiZn dan ZnO. Berdasarkan hasil EDX, material karbon mesopori berhasil dimodifikasi dengan logam nikel dan seng dengan persen *loading* 11,68%, untuk nikel dan 8,69% untuk logam seng. Katalis NiZn/MC kemudian digunakan sebagai katalis heterogen dalam reaksi karboksilasi asetilena dengan CO<sub>2</sub>. Reaksi dilakukan dalam reaktor *batch* dengan kondisi reaksi yang bervariasi, yakni tekanan 1,5 bar; 2,5 bar; dan 3,5 bar. Asam akrilat, sebagai produk yang diinginkan, tidak terdeteksi pada analisis dengan HPLC. Namun, terdeteksi spesi yang lebih polar pada waktu retensi 3 menit, di mana kondisi optimum terjadi pada tekanan 2,5 bar.

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Utilization of fossil fuel, charcoal, oil, and natural gases, which are carbon-rich materials, is widely used for human sustainability. However, utilization of such materials contributes to higher atmospheric CO<sub>2</sub> concentration. The increase of CO<sub>2</sub> emission leads to higher temperature and climate change ea t 'green house effect'. Therefore, conversion of CO<sub>2</sub> to value-added chemicals has drawn many attentions. In this research, carboxylation reaction of acetylene and CO<sub>2</sub> has been carried out using mesoporous carbon modified by nickel and zinc metals as heterogeneous catalyst. Mesoporous carbon has been successfully synthesized using soft template method with pluronic F127 as template and phloroglucinol as carbon precursor. Mesoporous carbon was then modified with nickel and zinc (NiZn/MC) using homogeneous deposition precipitation method, followed by reduction for 90 mins at 400 °C under a flow of H<sub>2</sub> (30 ml/min). XRD diffraction pattern showed peaks for 2θ around 31.79°, 34.54°, 36.31°, 44.04°, 51.51°, 56.51°, 62.22°, and 75.68°, indicating the presence of NiZn and ZnO. Based on the EDX results, the mesoporous carbon material was successfully modified with nickel and zinc with a *loading* of 11.68% for nickel and 8.69% for zinc. The NiZn/MC catalyst was then used as a heterogeneous catalyst in the acetylene carboxylation reaction with CO<sub>2</sub>. The reaction was carried out in a *batch* reactor with varying reaction conditions, namely pressure 1.5 bar; 2.5 bar; and 3.5 bar. Acrylic acid, as the desired product, was not detected in the analysis with HPLC. However, a more polar species was detected at a retention time of 3 minutes, where the optimum condition occurred at a pressure of 2.5 bar.

44.04<sup>o</sup>, 51.51<sup>o</sup>, 56.51<sup>o</sup>, 62.22<sup>o</sup>, and 75.68<sup>o</sup> which indicate the presence of NiZn and ZnO. EDX result revealed that mesoporous carbon material has been successfully modified by nickel and zinc metals, with 11.68% and 8.69% metal loadings for nickel and zinc, respectively. NiZn/MC catalyst was then used for carboxylation reaction of acetylene with CO<sub>2</sub>. The reactions were carried out in batch reactor with varied pressure, 1.5 bar, 2.5 bar, and 3.5 bar. Acrylic acid, as the desired product, was not observed in analysis with HPLC. However, more polar species was noticed at retention time of 3 minutes, where optimum pressure was found to be 2.5 bar.