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Recent Development On Heterogeneous Catalysts For Syngas Production Via Co_2 Utilization

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EXTENDED ABSTRACT

In the past decade, the excessive use of fossil fuels by rapid industrial development has brought several environmental problems such as the rising of global warming gases concentration, including carbon dioxide (CO2), in atmosphere. CO2 has become the focus of attention because of the position of CO2 as the primary greenhouse gas and the implication of its emissions on the problem of climate change. Recently, the concept the CO2 utilization to chemicals and energy products is promising due to the high potential market and promising benefits. One of the significant process in CO2 utilization is dry reforming, where CO2 is used for the catalytic reforming of hydrocarbons for the production of synthesis gases (syngas - hydrogen and carbon monoxide). Current research is focused on the dry reforming of alkane (methane, ethane, butane) [1,2] and alcohol (ethanol, methanol and glycerol) [3–5]. In recent years, syngas production from dry reforming of hydrocarbon via heterogeneous catalysts has recently attracted a considerable amount of attention, as demonstrated by the burgeoning number of publications (see Figure 1).

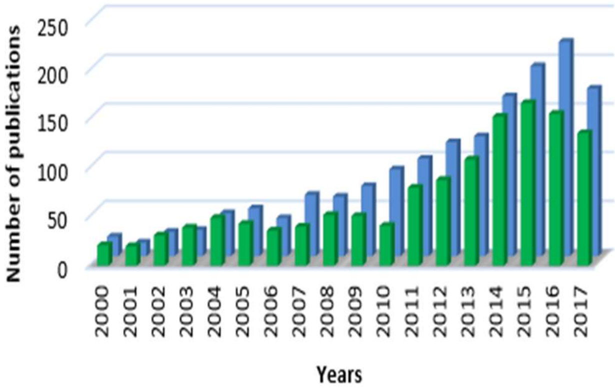

Fig. 1: Number of publication dealing with number of publications versus years (2000–November 2017) extracted from ISI Web of Science (Thomson Reuters) database retrieved using the keywords "carbon dioxide syngas catalyst (green bar)" and "dry reforming catalyst (blue bar)".

Study on the catalyst development of this reaction has been focused on screening a new catalyst to reach higher activity and better stability toward sintering, carbon deposition (coking), metal oxidation, and formation of inactive chemical species. Metals, such as Ru, Rh, Pt, Ir, Ni, Co, and so forth on various supports have been reported to be effective dry reforming catalysts reaction [1,6–10]. Among these metals, noble metals such as ruthenium and rhodium have been shown to be the most active and resistant from carbon deposition [11,12]. However, based on economical view, upscale toward industrial level of noble metals is not suitable considering their high cost and restricted availability. On the other hand, supported nickel is commonly studied because of its low cost and inherent availability. However, they suffer from deactivation due to carbon formation (with carbon tending to deposit and cover the active sites of the catalyst's surface), and metal particles sinterization, due to a lack of adequate thermal stability [13,14]. Thus, a new opportunity on the catalysis development on dry reforming of hydrocarbon need to be developed. For instance, tuning metal-support interaction can be a good strategy to enhance the catalytic activity and avoid catalyst deactivation.

The latest review on dry reforming catalysts was conducted by Abdullah et al. [15]. However, their review was primarily focused on nickel based catalysts for dry reforming of methane. Budiman et al. reviewed the dry reforming but only focusing on cobalt catalyst for reforming of methane [16]. While, Pakhare and Spivey focused on noble metal based catalysts for dry reforming of methane [17]. Therefore, there is a need to publish a comprehensive review to cover a large variety of catalytic system on dry reforming of hydrocarbon. We attempt to review and analyze the recent development of dry reforming of hydrocarbons through various catalytic systems between. The present review also attempts to provide current understanding of the catalytic performance and insight into the reaction mechanism over heterogeneous catalysts, as well as the future prospects of dry reforming catalysts.

Keywords: Heterogeneous catalysts; dry reforming; CO2 utilization; Coke-resistant catalysts

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