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REGULAR ARTICLE

# Alkali/alkaline earth ion-exchanged and palladium dispersed MCM-22 zeolite as a potential catalyst for eugenol isomerization and Heck coupling reactions

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**Abstract.** Alkali and alkaline earth metal ions ($Na^+$, $K^+$, $Cs^+$, $Mg^{2+}$) exchanged MCM-22 zeolites were prepared and subsequently palladium (2 wt.%; Pd) was dispersed on above exchanged MCM-22 zeolite materials. All the MCM-22 materials were systematically characterized by FTIR, powder X-ray diffraction, $N_2$ sorption analysis and temperature-programmed desorption (TPD) of $CO_2$. The XRD pattern and FTIR data confirmed the existence of the MCM-22 framework structure even after exchanging bulky metal ions and palladium loading. TPD studies using $CO_2$ supports that the cesium and magnesium incorporated MCM-22 possess a strong and large number of basic sites. The alkali and alkaline-earth metal ions exchanged MCM-22 catalysts were explored for industrially important eugenol isomerisation, whereas the palladium containing MCM-22 materials were utilised for Heck coupling reaction of styrene with iodobenzene. The Cs-MCM-22 showed the best activity for the eugenol isomerization with the isoeugenol yield of 76%. The Cs/Pd-MCM-22 was shown as promising heterogeneous catalyst for Heck coupling reaction of styrene with iodobenzene and yield 99% stilbene. For both isomerization and Heck coupling reaction, the catalysts retain their activities even after several runs.

**Keywords.** MCM-22; Cesium exchanged; Eugenol isomerisation; Palladium dispersion; Heck reaction.

## 1. Introduction

Heterogeneous catalysts play an extremely important role in fine, petrochemical industries, and also in environmental processes with high impact.[1] To our knowledge, the role of platinum on oxidation reaction studied by Faraday was one of the oldest processes using a heterogeneous catalyst.[2] Among the class of heterogeneous catalysts, zeolites and zeolite like molecular sieve materials have shown great interest since the 1960s, due to their molecular sieve properties and shape-selective in nature.[3] The exceptional stability, uniform porosity, and high surface area of these materials lead the researchers to focus on developing synthetic zeolite materials and explore its catalytic behavior.[3] Several unique features of these materials including uniform channels, cavities, tuneable active sites with different strengths, high adsorption capacity, and electronic properties make them viable for commercial applications. In particular, zeolites have been commercially used as catalysts for hydrocarbon conversions in petroleum and petrochemical industries, as well as adsorbents[4] for small-molecule separation processes, and even as ion exchangers in detergents.[5]

The development of zeolite having unique and wider pore channel accessible with the large surface area is one of the current interests in the area of heterogeneous catalysts. Recently discovered, two-dimensional layered zeolite, *viz.,* MCM-22, with a medium pore opening having an MWW topology is of great interest.[6] The MCM-22 having framework topology of the material includes two independent

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