# Session VII: Process Intensification

## Design and Development of Catalysts for Green and Economical Processes for Chemical Industry

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Prof. Lakshmi Kantam (PhD, 1982, Kurukshetra University, India) is Dr.B.P. Godrej Distinguished Professor of Green Chemistry and Sustainability Engineering at Institute of Chemical Technology, Mumbai, India. Earlier, she served as Director at CSIR-IICT, Hyderabad. She is an Adjunct Professor at RMIT University, Melbourne, Australia and Conjoint Professor at The University of Newcastle, Australia. She is a fellow of Indian National Science Academy, National Academy of Sciences, Indian National Academy of Engineering, The world Academy of Sciences, Italy, and Royal Society of Chemistry, UK.

Prof. Lakshmi's prizes include ICC -D.M.Trivedi Life time Achievement Award, Eminent Scientist Award – Catalysis Society of India and Vasvik award. She is a Member of scientific councils DST, CSIR, DRDO, IIT-Hyderabad, and DAE. She is Non-Executive Independent Director, Godavari Biorefineries Ltd , Vinati Organics Ltd, Prasol Chemicals Ltd and Indo-Amines Ltd.

Prof.Lakshmi has 38 years of experience in the research, design and development of catalysts for innovative green and economical processes for chemical industry. She has authored more than 355 publications, 42 patents and five book

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## Abstract

Catalysis is a highly demanded technology for sustainable society and drives innovation in many other fields. Achieving the high catalytic selectivity is the goal of catalysis science in 21st century. Today over 90 % of all industrial chemicals are produced with the aid of catalysts. World catalyst demand is forecast to grow to $34.1 billion in 2025 and earlier global sales of catalysts is around 20.6 billion dollars. The catalysis of organic reactions by homogeneous and heterogeneous catalysts remains a vibrant field of scientific inquiry. It attracts a diverse group of scientists with specialties spanning synthetic organic chemistry, inorganic chemistry, surface science, material science, reaction engineering and computational modeling.

Bio-compatible materials as supports and catalysts: Hydroxyapatite (HA) is a hydrated calcium phosphate material, which is an important biomaterial because of its similarity to the mineral component of mammalian bone. We have utilized these materials and their metal exchanged materials as catalysts for C-C and C-N coupling reactions. Similarly, hydrotalcites, anionic clays and the metal exchanged hydrotalcites have successfully applied in C-C coupling, C-H activation and oxidation reactions. Reactive nanocrystalline metal oxides are newly discovered materials that could change dramatically the way these organic transformations are carried out. Nanostructured metal oxides are widely used in catalysis where the acidic/base properties and the catalytic activities are closely related to the size and morphology of the oxides. Heterogeneous catalysts in the form of nanosize transition metal particles dispersed onto microporous supports have been applied to chemical conversion technologies for many decades. We have been exploiting different nanocrystalline metal oxides prepared by Prof. Klabunde for a number of organic reactions. These materials are also used as supports for the efficient exchange of different metal/metal ions, which are further used as supported metal catalysts for different organic reactions. Nitration of aromatic compounds is a ubiquitous reaction to realise organic intermediates required in large tonnages for the fine chemical industry. The conventional nitration process, employing a nitrating mixture of nitric and sulfuric acid, for the last 150 years has remained unchallenged in the commercial arena owing to uneconomical alternative options. We present a unique methodology for the nitration of aromatic compounds that offers near zero emission of effluents, especially high p-selectivity for monosubstituted products, essential for commercial processes, employing nitric acid at a concentration of 60–90%, with reuse of the solid acid catalysts. Overview of our work on the design and development of catalysts for green and economical processes for chemical industry will be presented.