# Romancing the Materials for Encapsulation and Nanodelivery of Molecules

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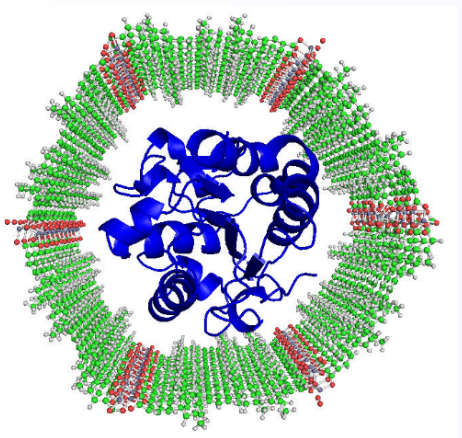
## GRAPICHAL ABSTRACT



## ABSTRACT

Application of advanced materials as novel supporting matrix for molecules and biomolecules immobilisation has engendered incredible interest in the chemical and biotechnology communities. The main reason of immobilization is to ease enzyme-product separation and to allow enzyme recyclability, persistency of functional activity rather than to stabilize enzymes and proteins. In particular, the robust nanostructured forms, such as nanoparticles, nanofibers, nanotubes, nanoporous, and nanosheets, possess a high surface area to volume ratios that can cause a high enzyme loading and facilitate reaction kinetics, thus improving biocatalytic efficiency for industrial applications. Several natural (kaolin, mica, feldspar) and synthetic (layered double hydroxide, metal organic frameworks, zeolitic imidazolate frameworks) materials were modified and characterised for enzyme immobilisation are highlighted. The developed immobilised lipases were used in several bio-organic reactions especially esterification, from lab scale to commercial scale. Amongst esters produced, palm-based esters and sugar fatty acid esters showed high conversion upto 95%. Molecular simulation of enzyme immobilised and behave in metal organic frameworks may offer better understanding in design future reticular materials.

Lately, nanomaterials can also be used in targeted nanodelivery of therapeutics and diagnostics to diseased tissues. New and modified nanomaterials such as mesoporous silica, iron oxide nanoparticles, graphene, metal organic frameworks, zeolitic imidazolate frameworks were used to encapsulate drugs for pulmonary drug nanodelivery. Globally, lung cancer has become the most common type of cancer cases. Various anticancer drugs have been extensively investigated for its pharmacological effects on lung cancer. However, clinical applications of hydrophobic drugs are limited due to poor solubility and low stability in aqueous medium. In this work, several nanoemulsion and nanoparticles systems were formulated and further characterized physico-chemically and aerodynamically. Addition of functional groups attached to the nanomaterials may help to increase the percentage of drug load as well as produce a controllable drug release process. The selection of appropriate support materials with tailored properties are critical for anticipated application and future investigations should endeavour at adopting logistic and sensible entrapment techniques. These could provide new perspectives to the industrial sector.

*Keywords*: advanced materials; drug nanodelivery; enzymes; immobilization; inorganic supports

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## BRIEF BIOGRAPHY

Mohd Basyaruddin Abdul Rahman is currently the Senior Professor of Chemistry and Dean, Faculty of Science, Universiti Putra Malaysia (UPM). He received his Ph.D in Catalysis Chemistry (University of Southampton) and post-doctoral in structural biology (University of Edinburgh). He was appointed as Distinguished Visiting Scholar at the University of California, Berkeley. His research areas include biocatalysis, chemical biology and computational chemistry. His interests encompass broad areas from single atom to complex biomacromolecules and bioinspired materials. His deep interests include designing metalloenzymes and nanobiomaterials as industrial biocatalysts for various specialty chemical reactions. Molecular interactions at the atomic level of protein-ligand-metal and transdermal nanodelivery systems are also being modeled. His extensive research in enzyme technology to produce immobilised enzymes, Chirazim and MBzyme (supports developed from natural materials and nanomaterials) aims to provide better alternatives to existing enzymes. Recent findings in peptide chemistry for example the antifreeze peptides and metallopeptides also has many potentials in frozen food and biomedical industries. Currently, he is developing several translational researches on aerosolised nanoemulsion systems and reticular nanomaterials as nanohubs for delivery of drugs for cancer treatment and delivery of pesticides for sustainable agriculture. He has published more than 200 papers, filed more than 30 patents and graduated more than 100 postgraduate students. He is the Fellow of Royal Society of Chemistry (UK), Institute of Advanced Materials (Sweden) and Academy of Sciences Malaysia. Currently he is the President, Malaysian Analytical Sciences Association and the Dean, Faculty of Science UPM. He has been received the Young Scientist award from various bodies including IUPAC, the American Chemical Society, and the InterAcademy Panel. He also won the National Intellectual Property Award 2009 and was named the most Outstanding Young Malaysian 2008 and Faces of Science@Malaysia. He also actively participates in professional academic trainings and STEM outreach activities.