



### Method for using Bulk and Porous N-containing/N-doped Carbon and Carbon Nitrides as Heterogeneous Catalysts for Borrowing Hydrogen and Dehydrogenation Reactions

#### IITM Technology Available for Licensing

#### Problem Statement

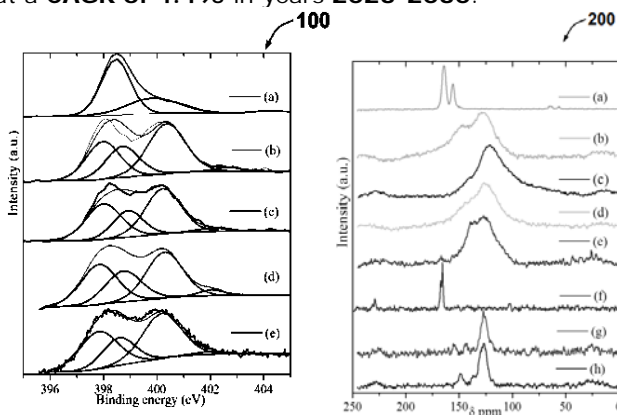
- **Repairing of the long segmental bone defects** is challenging in orthopedic practice.
- Limitations related with bone grafts use: **tissue availability, increased surgery time, donor site morbidity, high cost, uncertain bone healing, disease transmission risk & undesirable host immune response.**
- Most load-bearing metal orthopedic implants are made of **titanium/stainless steel** due to their **mechanical strength**, inertness or Osseo integration (titanium). Limitation of **stress shielding** with release of **toxic metallic ions** that enhance **inflammatory response**, inability to adapt human body growth & poor bioactivity, takes **long healing time or infection second surgery** to remove implant after **recovery**.
- To overcome these issues, the present patent is disclosed which relates **magnesium-based biodegradable metallic material, implant device for medical application.**

#### Technology Category/ Market

Categories: **Chemistry & Chemical Analysis, Medical & Surgical Devices**

Application: long segmental bone repairing, reconstruction of bones, bone flexibility

Market: Heterogeneous Catalyst Market size was valued at **\$ 40 B** in 2021 and is poised to grow from **\$ 41.76 B** in 2022 to **\$ 56.45 B** by 2030, growing at a **CAGR of 4.4%** in years **2023-2030.**



#### Key Features / Value Proposition

- **Provides flexibility** to the reconstructed bone.
  - **Avoids stress shielding.**
  - **Avoids second surgery**-Removes implant after healing.
  - Ability to accommodate various **bioactive molecules/ antimicrobial agents & its controlled delivery.**
  - **Improved bioactivity/biocompatibility.**
  - **Biomimetic**-mimics extracellular matrix (ECM) coating.
  - **Avoids infections** – implant associated infections.
  - Controlled corrosion, degradation via long term stability.
- FIG. 1 & 2 is graphical representation of XP spectra.

#### Technology

A method of preparation of a **catalyst of N-containing/N-doped carbons and carbon nitrides** said method comprising:

- **Preparing at least one N-containing/N-doped carbon materials with nitrogen containing carbon precursors;**
- **Pyrolyzing the resulting carbon nitrogen-containing/-doped carbon and carbon nitrides - in the temperature range of 500-1000 °C**
- **Centrifuging and washing the material with ethanol; drying to obtain the N-containing /N-doped porous carbons and carbon nitrides.**

- wherein **N-containing/N-doped carbons/carbon nitrides** additionally is **methylated** by suspending N-doped mesoporous carbon in methyl iodide (CH<sub>3</sub>I) reagent under stirring at **40- 100 °C (for 1-12 h) & centrifuging and washing** the material with ethanol; **drying** to get the N- methylated N-containing/N-doped carbons/carbon nitrides.
- The method of catalyzing one of the organic transformations such as N-alkylation of amines; C-alkylation of ketones; and synthesis of quinolines said method comprising steps of: reacting the **mesoporous N-containing/N-doped carbons and carbon nitrides catalyst prepared with respective amines or ketones or quinolines** with the alkylating reagent in a tube reactor charged with **inert gas in atmospheric pressure at temperatures 80- 140 °C for period of 1-24 h**, wherein the **catalyst is 5-50 wt%** with respective **amines, ketones and quinolines** in the presence **0.01 - 0.5 equivalent of a base**; carrying out the reaction by **stirring magnetically in hot oil bath.**

#### TRL (Technology Readiness Level)

TRL – 4; Technology validation in Lab

#### Intellectual Property

IITM IDF Number: 1674

IP Patent Number: 429993 (Granted)

PCT/IN2019/050532

#### Research Lab

Prof. Selvam P

NCCR & Department of Chemistry

#### CONTACT US

Dr. Dara Ajay, Head  
Technology Transfer Office,  
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:  
<https://ipm.icsr.in/ipm/>

Email: [smipm-icsr@icsrpis.iitm.ac.in](mailto:smipm-icsr@icsrpis.iitm.ac.in)

[sm-marketing@imail.iitm.ac.in](mailto:sm-marketing@imail.iitm.ac.in)

Phone: +91-44-2257 9756/ 9719