SCO-Young Scientist Profile

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Details of research work carried out in S&T (*limit to 200 words*)

I have been conducting research in the area of cascade engineered catalytic reactions which involves conducting multiple wolf and lamb reactions in desired sequence in same reactor, under same process conditions using a multifunctional nanocatalyst such that there are minimal byproducts. I demonstrated that copper could form an alloy with minimal amount of palladium so that it can be used in water without leaching and maintaining efficacy of copper as hydrogenation catalyst. Also, a cost-effective technology was developed to synthesize oxo alcohols in one pot with use of reusable catalyst and solventless condition. For classical oxidation processes using TEMPO catalyst to be clean, it is imperative to prevent leaching of TEMPO into water bodies. I developed a new catalyst wherein; TEMPO was anchored on magnetic nanoparticles such that it can be easily recovered and reused. I demonstrated the use of solid recoverable catalyst to modify solid biopolymers dispersed only in water was demonstrated for first time, which is breakthrough in this research area. The same reusable catalyst was also used to generate highest ever yield of vanillin, a valuable chemical for the bio-economy under room temperature and atmospheric pressure without generation of hazardous waste. I also developed the new metric, 'V-factor' that will greatly facilitate the development of environmentally and economically sustainable processes for valorization of biomass.

Associated SCO-YSC Theme: Sustainable energy and energy storage

Statement of Innovation ***(Brief information on new innovative ideas including startup / entrepreneurs- limit to 150 words)***

I am trying to develop new divergent catalytic technologies to derive value from biopolymers by accommodating their structural complexity and target scalable processing into chemicals and functional materials. A divergent technology is one in which the same technique can be used to obtain multiple products from multiple substrates (cellulose, hemicellulose, lignin in case of biomass). Based on this, I am currently developing a comprehensive process for utilization of agricultural waste. The biomass is fractionated using organosolv process. The cellulose and hemicellulose fraction can be sold to pulp and paper companies. These companies have a steady demand for cellulose and hemicellulose for pulping operations. Further, oxidative depolymerization of isolated lignin yields vanillin (20%) and oxidized polymeric or repolymerized lignin (80%). Vanillin has high demand from fine chemical industries. The oxidized polymeric lignin has carboxyl groups on its surface and altered glass transition temperature that makes it easier for fusing with other virgin components. It can therefore be used as filler in packaging and textile industries.

Major awards/ Achievements ***(Upto 3 awards)***

- Loksatta Tarun (Young) Tejankit (Illustrious) Award 2017 for developing new technology to utilize biomass using solid recyclable catalyst
- Industrial Green Chemistry World 2015 award from Green Chemistree foundation, India for developing a novel copper catalyst for valorization of biomass at high temperature and pressure using water as solvent.
- ISTE- IPCL National award for Best Chemical Engineering thesis for M.Chem.Engg. thesis. The award is instituted by the Indian Petrochemical Corporation Ltd. (IPCL) to promote research in chemical engineering at post-graduate level and is operated by Indian Society for Technical Education (ISTE). (2011)

Possible collaboration with SCO countries ***(limit to 100 words)***

Rice straw, unlike rice husk, cannot be used efficiently for energy applications owing to high ash content (15-20%). Rice straw cannot be used as fodder for livestock owing to high silica content (8-14%) that makes it indigestible. Also, it has low crude protein (2-7% on dry matter basis) that necessitates protein supplementation for livestock, and it is high in oxalates that decrease absorption of calcium in livestock. I intend to utilize rice straw to develop novel functional materials that will have applications in high volume textiles and apparel industry. Rice straw can be converted to 'lignonanocellulose' which means nanocellulose with residual lignin. The lignonanocellulose obtained from rice straw can then be converted into low density materials by suitable cryodesiccation treatment.

Shanghai Cooperation Organization- 1st Young Scientists Conclave (SCO-YSC 2020)
A virtual event organsied in India at CSIR-IICT, Hyderabad
Theme: **Shaping SCO-STI Partnership: Young Scientists Perspectives**

Key words ***(relevant to research work conducted as well as proposed innovation, 5-6 words)***

Biomass valorization, bioenergy, sustainability, oxidation, nanocellulose