Green Chemistry and New Technological Developments

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Abstract- The chemical industry plays a significant role in nourishing the world economy and underpinning future technologies. Scientific advances in new materials, less toxic products, renewable energy sources, environmental protection, industrial processes with energy efficiency and renewable raw materials are based on chemistry. Green Chemistry offers enhanced chemical process economics, concomitant with a reduced environmental burden. There are many fields of innovation for Green Chemistry technology. Organic photovoltaic solar cells have been developed for low-energy-production photovoltaic solutions providing electricity at a lower cost. The replacement of oil with biomass as raw material for fuel and chemical production is an interesting option for the development of bio-refinery complexes. Green Chemistry envisaged technological interventions for traditional farming practices that will reduce environmental pollution and increased yields of many crops. There is intensive research on renewable energy sources for sustainable storage technologies (batteries). An attempt has been made in this review to presents selected research papers on innovative green chemistry which are aiming to a sustainable future.

Keywords- green chemistry, renewable energy sources, organic photovoltaic solar cell

I. INTRODUCTION

Development of human civilization and the fulfillment of socio-economic needs of the present generation will be only possible if the natural resources are properly managed. Environmental pollution threats, ranging from atmospheric pollution in cities, municipal solid waste, acid rain, deforestation and desertification, the reduction of ozone layer and signs of climate change were overlooked. The idea of sustainable eco-development was presented for the first time in 1987 in the report of the World Commission on Environment and Development of the United Nations [1]. The global chemical industry plays a fundamental role in important scientific and technological fields associated with the future of sustainable development in developed and developing countries. Chemists are embracing sustainability challenges in order to minimize potential environmental and health implications of their technologies. The American Chemical Society (ACS) in the 1990s promoted sustainability, green chemistry, and green engineering, combined with incentives for the adoption of sustainable technologies and new regulatory strategies [2, 3]. The term Green Chemistry (or Sustainable Chemistry) was coined by Paul Anastas in 1991 within the framework of the U.S. Environmental Protection Agency (EPA) program. As a result, the comprehensive US Green Chemistry Program was established in 1993 [4, 5]. The chemical industry strives to be sustainable in terms of its operations and to be a key enabler of a sustainable society by implementing environmentally friendly science and technologies, natural resource efficiency, and safe chemical products for chemical workers and consumers [6].

II. GREEN CHEMISTRY FIELDS OF NEW TECHNOLOGICAL DEVELOPMENTS

The most important research and technological fields of Green Chemistry include solutions. Among other things, reduction of global warming and use of CO2 as a raw material for chemical synthesis, microwave, electrochemical and ultrasound synthetic methods, water as a solvent (or solvent free reactions), waste management, eco-friendly dyes, new innovative food products, bio-catalysis and biopolymer technology, renewable materials, renewable energy sources, etc. Although there are many fields of innovation for Green Chemistry products we list below some of the basic [7, 8].

- Green and renewable energy sources
- Green chemistry and agricultural technologies
- Green chemistry. Multicomponent reactions
- Green chemistry and biodegradable polymers
- Green chemistry and organic solar cells

Except for the above, there are also numerous other technological; fields of Green Chemistry that have been advanced in the last decade [9, 10].

III. GREEN CHEMISTRY AND ORGANIC PHOTOVOLTAIC SOLAR CELLS

Organic photovoltaic (OPV) solar cells provide electricity at a lower cost than first- and second-generation solar technologies. Organic photovoltaic cells have efficiencies up to 11%. Efficiency limitations and low durability are the weak points of OPV. OPV cells use molecular or polymeric absorbers, which is used in conjunction with an electron acceptor, (such as a fullerene) that. Improved absorber material can give substantial efficiency gains. To reduce cell degradation facilitate electron transfer [11]. Current research is focused on to increase device efficiency and lifetime and increase cell lifetimes improved encapsulation and alternative contact materials are being investigated [12].

Organic photovoltaic solar cells are regarded as low-cost and potentially environmentally benign sources of power. π-Conjugated (semiconducting) polymers—the components of organic solar cells are responsible for absorbing light and transporting charge—are not typically synthesized in laboratories in ways that are amenable to manufacturing with low environmental impact [13]. Scientists are working with various projects to improve polymer solar cell efficiency by using tandem structure. A broader part of the spectrum of solar radiation is used and the thermalization loss of photon energy is minimized. The lack of high-performance low-band gap polymers was the main limiting factor in the past for achieving high-performance tandem solar cell [14].

IV. Green and Renewable Energy Sources

Applications of Green Chemistry are also beneficial in the acceptance and usage of renewable energy resources. These benefits promote the development of sustainable energy processes. There are many examples of green chemistry successes in the fields of renewable energy [15, 16]. The replacement of oil with biomass as raw material for fuel and chemical production is an interesting option for the development of bio-refinery complexes. In bio-refinery, almost all the types of biomass feedstock can be converted to different classes of biofuels and bio-chemicals through jointly applied conversion technologies. This technological change needs an integration of Green Chemistry into bio-refineries, and the use of low environmental impact technologies, future sustainable production chains of biofuels and high value chemicals from biomass [17, 18].

Biomass (especially woody biomass, forest residues, agricultural residues and energy crops) is the most widely used raw material for the production of renewable energy fuels. Woody biomass is preferred material in thermochemical processes due to its low ash content and high quality bio-oil produced. Thermal conversion by fast pyrolysis converts up to 75% of the starting material into renewable biofuel suitable for transportation. Formulation or blending of various feedstock, combined with thermal and/or chemical pretreatment, could facilitate a consistent, high-volume, lower-cost biomass supply to an emerging biofuels industry. Industrial experience in the production of biofuels showed the importance of integrating biofuels production with the production of high-value biomass fractions in a bio-refinery concept. The sustainability of these renewable resources can be achieved through the synergistic coupling of microalgae propagation techniques with CO2 sequestration and bioremediation of wastewater treatment [19]. A recent review summarized the results of numerous research papers that have been published in the last decade projecting the current state of knowledge regarding the effect of feedstock and pretreatments on the yield, product distribution, and upgradability of bio-oil [20].

V. Greener Electrochemical Storage Systems.

With the investigation of renewable energy sources, it was essential for researchers to design of new electrochemical storage systems incorporate eco-efficient synthetic processes. At present, a few innovative existing technologies address these issues. Sodium ion batteries (NIBs) based on intercalation materials that employ non-aqueous electrolytes were first explored in the mid-1980s. They have undergone a renaissance in the few years because they hey offer a higher energy density than aqueous batteries and lower cost than Li ion batteries. The sodium ion batteries offer sustainability and cost-effectiveness and are considered as a green alternative for storage of energy [21].

The innovative material Graphene (which was isolated in 2004) has influenced the world of electrochemical energy-storage devices. But despite widespread initial enthusiasm for the role of graphene as material for energy storage there is no any advances in the field. In recent years research was performed on the applications of graphene in lithium-ion batteries and electrochemical capacitors. Also, grapheme materials were used in emerging technologies such as metal–air and magnesium-ion batteries [22]. Although insertion electrode materials for Li (Na)-ion batteries met initially these requirements, scientists advanced their research into many different areas and re-engineered for extension to larger-scale applications [23].

VI. Green Chemistry and Innovative Agricultural Technologies

The spread of Green Revolution in agriculture affected both agricultural and wild life biodiversity, increased environmental pollution, caused water management problems and agricultural soil scarcity [24, 25]. Green Chemistry envisaged technological interventions and applications for traditional farming practices that will reduce environmental pollution and increase the sustainability of agricultural methods. Alternatives based on principles of green chemistry are vital to sustainably producing agricultural goods without continued dependence on toxic chemicals. New improved technologies can lessen the occupational hazards to farmers and prevent to pollute important environmental resources (soil erosion, water sources, and ecosystems). Great variety of innovative green technologies, such as protecting soil from erosion, conservation of biodiversity, climate change adjustments, water management of irrigation, and intensive research of green techniques for biomass transformation into fuels and platform chemicals are promoted in the last decade in many countries [26, 27].

Heavy reliance on use of nitrogen fertilizer to support high yields is perhaps the Achilles heel of modern crop production. However, its misuse has negative impacts on water quality (nitrogen pollution) and climate through emissions of nitrous oxide (N2O). Unlike chemical fertilizers, bio-fertilizer technology (advanced by Green chemistry technologies) is based on renewable resources of energy and does not contribute to environmental pollution. As a low-cost green technology, bio-fertilizer technology is most suitable for developing nations where labor is inexpensive. Various micro-organisms and associations with plants which are involved in bio-fertilizer production as well as their usage on the farm are considered as advantageous. Research showed benefits to small farmers who used these bio-fertilizers in India. Future innovative bio-fertilizers will probably contain a blend of nitrogen-fixing and phosphate-mobilizing micro-organisms [28].

VII. Conclusion

Green Chemistry is gaining substantial importance for new technological developments. This is the result of their sustainable nature, energy efficiency, and reliance on renewable raw materials, less toxic chemicals and lower cost. All these green-technology ventures are increasingly gaining importance in the face of global environmental degradation. Green Chemistry initiated innovative ideas to overturn serious environmental problems, to provide safer products. Use of energy must be sustainable and from renewable sources. The challenge for future generations of chemists is to develop the technical tools and approaches that will integrate environmental objectives into design decision in the modern chemical industry.

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