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Contributing to Vision 2030 with a Saudi Polymer Research Center

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Abstract

The Saudi Arabian's Vision 2030 presents a national transformation plan to boost the economic development through the establishment of several sustainable projects. The creation of powerful research centers to enhance the productivity of industrial, pharmaceutical, and environmental sectors is vital for the Saudi's Vision 2030. The commissioning of a Saudi Polymer Center (SPC) can accelerate the vision 2030 significantly. This paper briefly outlines the role of SPC to revolutionize the industrial and biomedical fields in the kingdom by initiating and implementing several vital research projects. The potential research projects and economic benefits of creating a polymer research center in support of the Vision 2030 are covered in this paper.

Keywords: Saudi Polymer Research Center; Vision 2030; Pharmaceutical; Nanostructured; Nanocomposites

Introduction

The Kingdom of Saudi Arabian's Vision 2030 (KSA) focuses on three fundamental principles. The first includes development of a vibrant society with strong roots in our national resources to ensure physical and psychological benefits in people's lives. The innovative instructive foundations in learning and education can develop a strong and productive society. The second core includes developing a thriving economy through rewarding opportunities, evolving the learning methodologies in our institutions to prepare people for the contemporary work environment. The aim also includes attracting the high potential talents to achieve Vision 2030. These primary practices need to be imbedded in all Saudi educational institutions. The third principal advocates for development of an ambitious nation through raising the Saudi global ranking in the logistics performance index and increasing non-oil government revenue.

It is vital to understand the country's vision and plan multiple projects to contribute in sustainable economic growth. The sustainability of project and consistent performance in serving any changes in the society's need is essential. Numbers of research centers have been established in certain Saudi universities and companies to serve Vision 2030. This paper discusses establishing a Saudi Polymer Center (SPC) that can serve in advancing the industrial, environmental, pharmaceutical, and biomedical sectors to support Vision 2030.

Polymers Research in Vision 2030

The polymer nanostructured materials for industrial, medical and environmental applications have witnessed tremendous progress in recent years due to vast potential [1-3]. The polymer nanocomposites can form materials with specific mechanical properties (e.g. wettability, permeability, adhesion, adsorption). The research shows that industrial, environmental and biological conditions can alter these properties towards the desired characteristics. The below discussion is about numerous applications of polymeric materials. The SPC can develop these materials to enhance the industrial, environmental, and pharmaceutical production of polymeric materials in the KSA.

Industrial and Environmental Applications

The International Energy Agency (IEA) reported 13% of the world's oil production came from Saudi Arabia in the year 2014 [4]. Figure 1 represents the significant increase of the supply of crude oil and natural gas in comparison to the zero supply of other energy sources, such as biofuels, electricity, and heat in the KSA. Contrarily, Figure 2 shows an increase in the Saudi consumption of oil products up to 2014. However, the Ministry of Energy, Industry, and Mineral Resources aims to achieve Vision 2030 by increasing the non-oil commodities exports considerably. It aims to increase the value of exports on non-oil commodities by 2020, from 185 SAR Bn to 330 SAR Bn [5].

The establishment of SPC will support the production of non-oil products and consequently will increase the export of non-oil commodities. The Saudi Polymers Company (SPCo) , which is located in Jubail, manufactures several kinds of polymers such as polyethylene, polypropylene, and polystyrene [6]. The SPCo distributes these products through the Gulf Polymers Company to serve growing demand of the

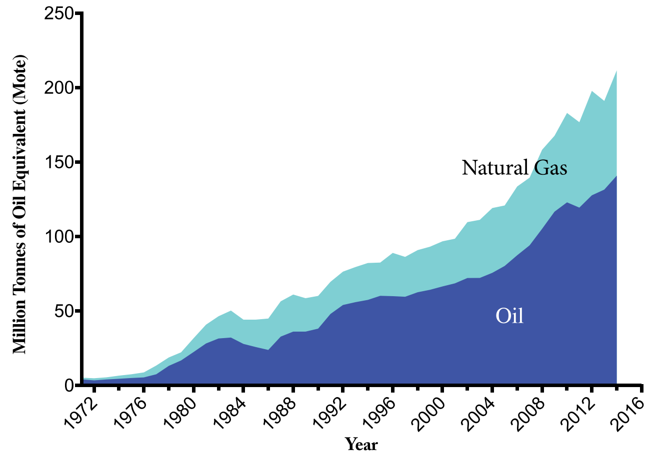

Figure 1: Total primary energy supply by the Kingdom of Saudi Arabia. The data excludes electricity trade.

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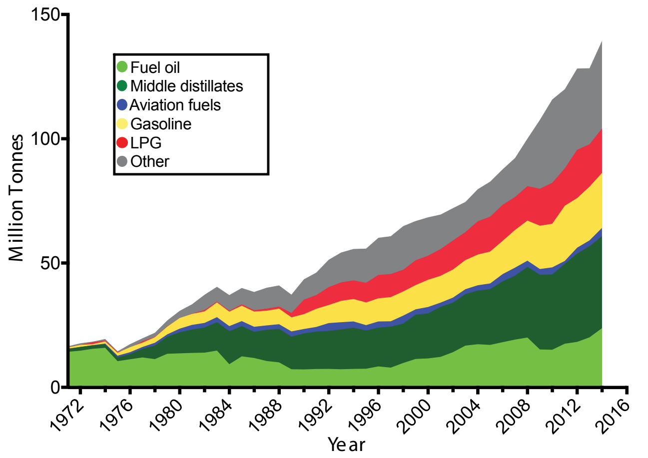

Figure 2: Consumption of oil products in the Kingdom of Saudi Arabia. The consumption includes international bunkers. The LPG includes LPG, NGL, ethane and naphtha. Other also includes direct use of crude oil and other hydrocarbons.

world. The establishment of an SPC will broaden the scope of advanced products by incorporating nanotechnology to achieve innovative functional materials.

Several polymers and polymer nano-structured materials have been studied and developed to serve in various industrial and environmental applications such as the following:

Oil and gas applications: Most oil fields inject water into underground reservoirs to maintain the reservoir pressure and to sweep oil into production wells (water flooding). However, this operation recovers less than 50% of the original oil in place. Thus, there have been several studies researching methods to enhance oil recovery including thermal methods, chemical methods, and gas injection [7]. In 2015, a paper reported the usage of high acyl gellan gum (polymer) to enhance the petroleum production [8]. The study of the rheological behavior of the polymer shows that it maintains a high viscosity under high salinity conditions, therefore enhancing oil recovery. Another study by the same author shows that Schizophyllan, which is a biopolymer used in skin care products and as an immunity enhancement agent, holds its viscosity even at 100◦C. The study shows that injecting the Schizophyllan solution into planes causes the oil to stratify and improves the oil production [7].

Energy applications: The usage of polymers in fuel cells is under the development to replace batteries for cellphones and computers [9]. A thin layer of polydopamine (PDA) on the surface of polyvinylidene fluoride-hexafluoropropylene (PVDF-HFP) to fabricate a nanocomposite membrane (PVDF-HFPPDA) provides a high-safety lithium-ion battery [10]. The thin layer increases the thermal stability, and enhances the electrolytes uptake. It also improves the manufacture and long-term performance of the battery by boosting its mechanical and tensile strength. Photodeformable polymers have been studied for energy applications. Interestingly, photodeformable polymer materials can be used as a driven component for micromotors. These polymers are a green energy source that can convert light to mechanical energy to rotate the micromotors continuously [11]. Extensive research to develop photodeformable polymer materials can enhance the efficiency of these materials and the resulting energy production.

Safety and defense applications: Prince Mohammad bin Salman stated that, “As we continue to give our army the best possible machinery and equipment, we plan to manufacture half of our military’s needs within the Kingdom to create more job opportunities for citizens and keep more resources in our country” [12]. Establishing an SPC will lead to the Prince’s goals in developing many fundamental applications for the military.

Research has shown that Poly (Acrylic Acid)-Poly (Vinyl Alcohol) hydrogels can be used to make reconfigurable lens actuators [13]. These lenses provide automatic focus in machinery optics without any moving parts. The study of anisotropic self-assembly for spherical polymer-grafted nanoparticles is one of the research directions that is partially supported by the US Army Research Office [14]. Polymers have also been used in textile materials with specific properties such as breathable coating materials [15]. Flame retardant nanocomposites of natural and synthetic textile polymers have been developed for numerous safety applications [16].

Automotive applications: The International Journal for Automotive Technology recently published a paper on the use of glass/polyester composite structure in designing and manufacturing lightweight vehicles with high specific energy absorption value [17]. This research can be further advanced to meet the needs of nanocomposite materials in automotive applications.

Environmental applications: Enhancing the livability of Saudi cities and saving the environment and natural resources are two core objectives in Vision 2030. Polymers have been used to solve water contamination problems since 1979 [18]. Extraction of organic contaminants from water with a porous polymer is a method used to isolate compounds dissolved in water. In other applications, polymer nanofibres have been used in oil-water separation [19]. Ion-imprinted polymers have been identified to selectively and efficiently remove trace metal such as Nickel from natural waters [20]. The usage of green polymers and proteins such as agricultural polymers for packing production are some of the significant environmental strategies that can sustain Vision 2030 [21,22].

The Pharmaceutical and Biomedical Applications

The KSA Vision 2030 aims to provide citizens with knowledge and skills to meet the future needs of the labor market including the pharmaceutical industry. Pharmacists have been developing many effective drugs to improve health and to extend lives. The efficiency of these drugs depends heavily on the drug delivery systems. Nanotechnology has provided us tools to engineer and control the release of therapeutic agents at the sites of action [23-25]. The use of polymeric drug delivery systems has been enhancing the efficacy of drugs for the last few decades and the future will require further improvements [3]. Establishing an SPC with labs focused on improving the drug delivery systems is expected to enhance pharmaceutical knowledge and application in our society.

Targeted drug delivery: Polymers have played an integral role in the innovation of imaging, biosensing, and drug delivery technology [26-28]. Polymer nanoparticles can control drug release at the desired anatomical site, over periodic and cyclic dosage, and for both hydrophobic and hydrophilic drugs. Polymers of controlled molecular architecture can be engineered to give a well-defined response to internal biological stimuli such as, pH and hyperthermia [23,27]. They have also been engineered to respond to some external stimuli like light intensity and magnetic operations [29,30]. The pharmaceutical and biomedical labs in an SPC can develop attractive and financially-viable pharmaceutical sub-sectors.

Doxorubicin, an effective cancer treatments can be injected to pH sensitive micelles in order to target tumor cells and avoid its accumulations in healthy cells [31]. Future drug delivery systems based on polymers such as polyethylene glycol (PEG) should have the ability to cross the blood brain barriers and treat neurological and psychiatric disorders. Such research and more would lead to develop an ambitious nation through raising the global ranking of KSA in the logistics performance scale.

Painless injections: Pharmaceutical agents conjugated with polymeric drug delivery vehicles show promising signs of being able to improve the lives of patients [2]. Microneedle patches that are made of biocompatible polymers have been studied for painless transdermal drug delivery and vaccination [32]. Developing polymeric nanoparticles to carry the desired insulin dosage could eliminate the need of unpleasant injections to diabetic patients [33].

Management of infectious diseases: One of the strategic objectives of the Ministry of Environment, Water and Agriculture to meet Vision 2030 is to monitor and control the spread of cross-border veterinary diseases [5,12]. Establishing an SPC should support this objective. The field of polymeric drug delivery vehicles has shown success over the past few decades in delivering bioactive agents and modifying their intensity to treat epidemics of chronic and infectious diseases. This can lead to target specific pathogens like human coronavirus (hCoV), the emerging Middle East respiratory syndrome coronavirus (MERS#CoV), and general bacterial infections [34].

Conclusion

Polymer research will support Vision 2030 in creating an attractive environment for both local and international investors and enhance their confidence in the economy of the region. Local petrochemical companies can be engaged to support an SPC in developing new techniques to increase efficiency, thus enhancing their sustainability and providing new niches in the rapidly growing industrial applications. An SPC can be the source that we need to attract the talents to achieve Vision 2030. An SPC can be one of the Saudi universities' projects that the Kingdom needs in order to encourage a strong and productive society and enrich the lives of people with psychological and physiological benefits.

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