Earth materials like Bauxite Ore as Strategic Material for Advanced Technological Applications and Beyond.

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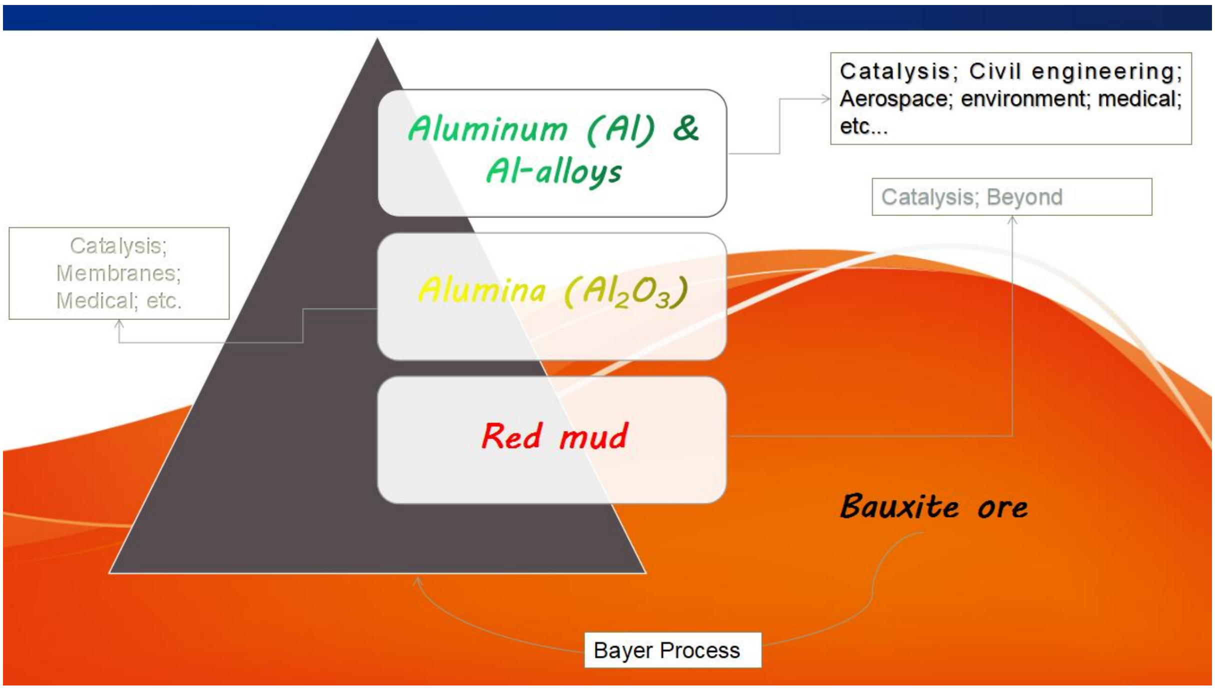
Abstract

Owing to the worldwide mass growth and environmental global changes, the development of sustainable materials for advanced technologies must be accelerated to satisfy the mankind needs and as well as limit the impact of climate change. So, going to this sense, here, it is discussed the valorization of an earth rich material named as bauxite ore, which is highly localized in many lands of Republic of Guinea and as well as in other cities in the world. In fact, as a result of our survey, it found that this raw material (Bauxite ore) might be considered as a potential or strategical source for intelligent hybrid materials engineering for a wide range of ways for the advanced technologies development. It found that, Bauxite ore is main source of both aluminum (Al), and aluminum oxides (Al_2O_3). these products have larger applications in our daily life, including catalysis, medical, environmental, and as well as in aerospace applications. And a by-product is generated under Jesef Bayer process of Bauxite ore processing, which is the (red mud) that stay a very challenge in this process. However, it could be a potential material as catalyst or a catalyst component for other industrial technologies. Therefore, in this paper, it is revised to the bauxite to (Al_2O_3/Al) as an alternative strategical materials engineering for high-tech uses.

Keywords: Earth-Materials-Bauxite ore, Industry, Environments, Catalysis, Engineering, Technologies

Graphical Abstract



1. Introduction

Valorization of earth resource materials such as Bauxite ore, rare earth transition metals [1,3], and transition metal oxides [4,7] must be accelerated for sustainable technological development as they possess a wide range of properties, and could be largely disposable under the earth, and as well as might be cost-effective as compared to the noble metals and as well as some xd transition metals. So, among these chemicals, aluminum oxides (Al_2O_3) is valuable industrial material with many technological utilizations, its large uses are for the generation of aluminum metal (Al). It is noted from [8] that the generation of Al and Al_2O_3 has been almost continuously growing in the past few decades. In 2015, higher than 57 million tons essential Al was produced, whereas the global Al_2O_3 production was larger than 115 million tons. Indeed, the principal raw material sources for alumina generation are bauxite and nepheline ores. Other sources such Al_2O_3 extraction from Kaolin and high Al_2O_3 containing clays have been featured. So, for that, according to the Jesef Bayer process, Alumina is generated via Bauxite Ore processing, where bauxite ore is digested with lime addition by sodium hydroxide solution (NaOH). The following **fig.1**, gives a brief description of this natural resource processing to yield the well-known material (Al_2O_3) which can subsequently might be considered for a wide range of applications, including catalysis, medical technologies, environment uses, and Aluminum (Al) and its alloys engineering.

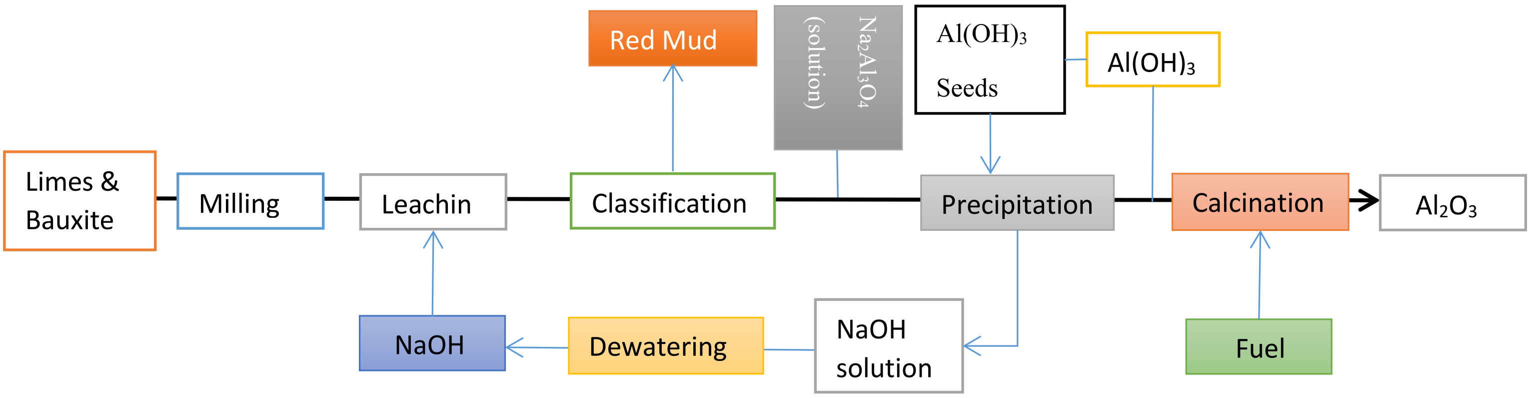


Fig.1. *Alumina (Al_2O_3) producing from Bauxite through the well-known Jesef Bayer process*

So, under this process, a byproduct is generation (red mud) which is viewed as waste under the Al_2O_3 production and might be a challenge for this process. However, as thoughts in Sushil's research [26], red mud could be as catalyst and it might be good alternative to the present commercial catalysts. So that due its properties such as iron content in form of ferric oxide (Fe_2O_3), sintering resistance, goodly surface area, resistance to poisoning, and as well as its cheapest price make it an attractive prospect catalyst for many reactions and beyond. Therefore, in this paper, it is revised from bauxite to (Al_2O_3/Al) as an alternative strategical advanced materials for high-tech uses

2. From earth element (Bauxite) to its valorization in engineering for catalysis, industry, medical, and environmental technologies

The earth element (Bauxite) distribution are surveyed in Patterson, S's research report [9]. So, the total world reserves are estimated to be 5.7 billion tons and that marginal and submarginal resources are 8.7 billion tons. According to this analysis, it found that Australia get the first rank in the bauxite reserves with (35.0 %), followed by the Republic of Guinea (20.0 %), 10.0 % for Jamaica, 5.0 % both in Hungary and Yugoslavia, and the last one is 4.5 % for both Surinam and Ghana. The article also has also given a fully description of the marginal and submarginal of the world resources distribution. In fact, the following **Fig.2** gives the world bauxite marginal and submarginal resources idea.

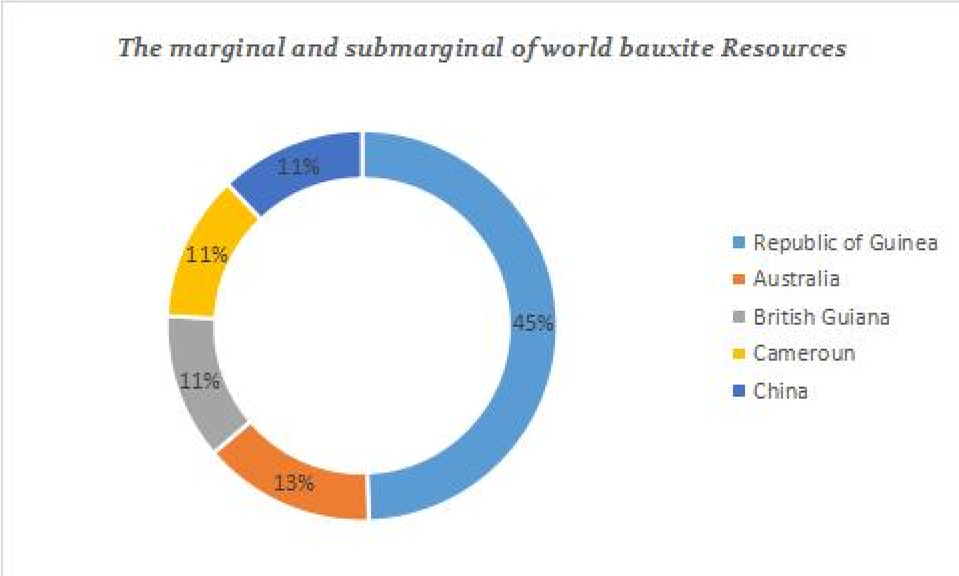


Fig.2. *The marginal and submarginal world bauxite resources distribution*

So, other lands may possesses adequate reserves and resources to hold up significant bauxite production for many period of time which include India, France, and so fourth. Indeed, as know bauxite is primary source of both Alumina (Al_2O_3) and aluminium (Al) and Aluminium derivatives such as Al alloys. Alumina is first obtained from bauxite processing via bayer process which can generate a considerable amount of by-product such as red mud. In fact, Alumina, Aluminium, and as well as red mud, all three are so beneficial in our society needs. So, here are some applications of these bauxite-derived products such as in membranes technologies, medical areas, and as well as in catalysis domains. The exploration and development membrane materials grown exponentially in recent years due to its interest in utilizing inorganic membranes, especially microporous ones as shown in Hsieh, H. P. et al's research paper [10]. Membranes engineering for industrial effluent treatment are so attracting. In this sense, Peters. Cartwright, P. [11] established a review to consider some of the chance offered by membrane process in this particular issue. Therefore, it is concluded that there are no easy solution, no single discipline is the for all problems. γ-alumina double-layered ultrafiltration (UF) membrane has been proposed and develop in He, Z., et al's research [12] with novel position pore-sized active layers and single-layered (UF) membranes generated utilizing one approach with adjustment of the pore size of Al_2O_3 microfiltration (MF) membrane. Also, a tubular C/Cu decorated γ-alumina membranes was reported in Yakoumis' research work [13] for NO abatement. This modified tubular γ-alumina ultrafiltration membranes with sodium alginate was used as a strained flow membrane reactors. Lee, W., et al [14] reported a fast synthesis of long-range ordered porous Al_2O_3 membranes by anodization method. The fabricated porous materials shows enhanced features. By etching process of porous alumina membranes, an Al_2O_3 nanotubes and nanowires was elaborated in Xiao's research paper [15] for membranes technologies. Moreover, Al_2O_3 engineering applications is also considered in medical technologies due to its powerful capabilities. So, it is known that metal oxide nanoparticles (NPs) possesses fortified antimicrobial properties. Indeed, Sadiq, I. M., et al [16] an Alumina (NPs) as antimicrobial which has higher sensitivity to well known Escherichia Coli. It is described that Al oxides (NPs) possess a wide-range applications in industrial and as well as personal care products. Al_2O_3 NPs induce expression of endothelial cell adhesion molecules is introduced from Oesterling's research paper [17]. Indeed, human endothelial cells treated with Al_2O_3 particles demonstrated enhanced adhesion of activated monocytes. However, it is reported that exposure to ultrafine particle may be a peril for the development of vascular diseases due to pathology of the vascular endothelium. Also, Vilchez-Aruani, J., et al [18] reported the effect of nanostructured Al_2O_3 (NSA) insecticide in human central blood lymphocytes in vitro. In fact, results exhibits that NSA particles are non-genotoxic and non-cytotoxic at the evaluated doses and do not cause obvious DNA harm in human peripheral blood lymphocytes (PBL) in vitro. Furthermore, Buteler's group [19] developed a nanoalumina dust as insecticide against Sitophilus Oryzae and Rhyzopertha Dominica. So, the results exhibit that insecticidal activity is dependant on particle size, morphology and surface area. However, analysis indicated that maximizing surface area, and minimizing both particle size and morphology do not ensure sole dominant factors influencing efficacy. Alumina is also largely used catalysis technologies, so here are some discussed papers concerning this powerful material. Indeed, Al_2O_3 substrates with cylindrical parallel pores were introduced by Rai's research group [20]. It is suggested that such samples may be helpful for quality mass transport with reaction in catalyst orifice in single pellet reactors. Also, unsupported versus supported nickel (Ni) NPs as catalysts for steam/ ethanol conversion and carbon dioxide methanation has been discussed in Riani's group [21], the supported one outperformed the unsupported. Also, an steam reforming of methanol over Cu-ZnO catalysts supported on Alumina is discussed in Jones' research work[22] the catalysts showed enhanced performances. A nickel hybrid NPs anchored on Al_2O_3 nanoparticles cluster is reported by [23] for cooperative catalysis of methane dry reforming. Also, a palladium (NPs) loaded over Al_2O_3 surface via chemical co-precipitation route and catalytic applications is fully shown by Kumar's research team [24]. Many technological applications were demonstrated such as Suzuki Coupling, alkyne and alkene hydrogenation, Hiyama Cross-Coupling, and as well as aerobic oxidation reactions. Naik, B et al [25] reported a preparation of Ag NPs anchored mesoporous γ-Al_2O_3 catalyst and its catalytic performance for the reduction of 4-nitrophenol with enhanced activities. Furthermore, a by-product of alumina production from bauxite processing via bayer process which is red mud has been reported as an active material for catalytic applications as shown in Sushil's research paper [26]. The use of red mud as catalyst might be good alternative to the present commercial catalysts. The offered properties of this material such as iron content in form of ferric oxide (Fe_2O_3), sintering resistance, considerable surface area, resistance to poisoning, and as well as it cheapest price make it an attractive candidate catalyst for many reactions and beyond. Brough's research group [27] reported a review on the aluminium (Al) industry << state-of-the-art>> engineering, environmental consequence and prospect for waste heat recovering. It is described that Al is seemly widely used across industries due to its advanced features, generally within an alloyed form. The paper outlines the whole production process of Al from ore to the processed metallic alloy product. Geza, B et al [28] also established an historical review on (vulnerability in the Al_2O_3 and primary Al industry). It is suggested that promulgated epidemiological studies and quantitative prospect data for bauxite mining and Al_2O_3 refining are nearly non-existent. Also, Nappi, C. [29] reported the global aluminium industry 40 years from 1972. it is taught that today, the global Al industry has only above similitude to what it was in the early 1970 s. So, the most sensible structural changes are geographical relocation of bauxite, Al_2O_3, and Al production centres, shifts in the level of concentration. Nordheim, E. [30] showed a sustainable evolution inductors of European Al industry. So, the industry study response was very positive, with an exhaust industry coverage founded on tonnage reported over 80% for 2002 and 70% for 1997 data respectively. Also, Rambabu's paper [31] discussed about aluminium alloys for aerospace applications. A full description of Al alloys was addressed in this chapter of book Aerospace Materials and Material Technologies. Such as a brief look across of the historical evolution of aerospace Al alloys, range of current alloys with description of the alloy order. Also, a survey of the physicochemical properties was considered in within this study. At the end a critical review of some of the gaps in present aerospace Al alloy technologies was elucidated. Therefore, here it is fully shown the importance of earth mineral bauxite as it is central material for generating Al_2O_3, Al, Al alloys and as well as red mud product, as all three are very involved in many industrial, medical and environmental technologies. So, the exploration of this should be accelerated in our society to fulfil the mankind needs.

3. Conclusion

Due to the sophisticated properties of some rare earth based materials, their exploration for advanced materials design and synthesis must taking at higher levels. So, it permits to valorization of these earth ample minerals and as well as will decrease the cost of hybrid materials as compared to many transition metals. So, in the same way, here, it is discussed the valorization of an earth rich material named as bauxite ore, which is extremely identified in Republic of Guinea and as well as in other cities. Indeed, our survey found that this raw material (Bauxite ore) could be considered as a strategical source for intelligent hybrid materials engineering for a wide range of technologies fields. It found that, Bauxite ore is the direct source of both aluminum (Al), and aluminum oxides (Al_2O_3). Both of them have larger applications in our daily life, including in catalysis, medical, environmental, and as well as in aerospace fields. And the by-product generated under Jesef Bayer process of Bauxite ore processing, the (red mud) stay a very challenge in the process. However, it might be a possible material as catalyst or a catalyst part for other industrial technologies. Hence, in this article, it is reviewed from bauxite to (Al_2O_3/Al) as an alternative strategic materials for engineering technologies.

4. Conflict of Interest

The Author declares that this article on Bauxite and related materials was led in the absence of any bankable or sellable relationships that could be taken as a possible conflict of interest.

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