SEMICONDUCTOR CRYSTALS WITH APPLICATION IN ELECTRONICS

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ABSTRACT

This work proposes the application of an electromagnetic semiconductor to the electronics industry. A protein enzyme with amide-based chemical compound is obtained from the biochemical digestion reaction of contaminated mangrove waste. The solution has PI 1105934-6 granted by the INPI in 2022. A microbial consortium of biofuel by-products, associated with microorganisms, deposited in a microorganism bank, is used under controlled conditions. In addition, it reports the production of crystals, with characterization data that indicate that it is an inorganic product at the nanometer scale, carbon silicate, and semiconductor, with electromagnetic characteristics. As a result, the present work brings an environmental biotechnology product with potential application and use in sensors, electrical devices, materials science and nanotechnology.

Keywords: Sensors 1. Semiconductors 2. Bioremediation 3. Fungi 4. Electronics 5.

1 INTRODUCTION

The contemporary world today demands new materials and more advanced and miniaturized electronic instruments using semiconductor with a challenge to be economically feasible.

During the COVID pandemic period, the advance of the home office in the economy and distance education heated up the market with the demand for electronics on the one hand, and on the other hand, the microchip supply crisis reduced their supply. As a reaction, the impacted sectors are changing the way they negotiate with their suppliers, while governments are positioning themselves to act and attract investments in this area and reduce dependence on the global chain. The discovery of both new raw materials and more efficient and miniaturized electronic instruments is urgent [1,2]. Any investment in this sector has great impact in the world economy from the electronics and household appliances to the automobile sector [3,4].

A raw material was produced, silicate crystals and mineral carbon, semiconductor, with electromagnetic characteristics. It is a low-cost product produced by the microbial action of fungi, breaking peptide bonds of polycyclic aromatic compounds of hydrocarbons in clay substrates of the ecosystem. Regarding to the chemical nature of new material, the amide is present in its constitution, bringing a polar behavior. As it is an environmental bioremediation product, it can be produced and sold in quantity with a favorable environmental cleaning impact[5,6].

This work aims to apply semiconductor crystals as raw material in the production of chips used in the manufacture of various electronic devices, many built on a microscopic scale in the technological scenario such as main market niche involving its application in industry.

2 MATERIAL & METHODS

The bioremediation work was carried out with fungi in oil-contaminated mangrove sediment, a clayey substrate of the ecosystem, which resulted in the production of small filaments of halite crystals (NaCl), after 90 days. A transforming agent is a microbial consortium, that was prepared to simulate the bioremediation of mangroves contaminated with waste from the oil industry. The area is located in the northeastern portion of “Baía de Todos os Santos” (BTS), considered the largest and most important bay navigable area of the Brazilian coast located between the municipalities of Madre de Deus, Candeias and São Francisco do Conde, is representative of the Atlantic Forest Biome, in the mangrove ecosystem. However, it is close to the oil production, refining and transportation area of Landulfo Alves - Mataripe Refinery (RLAM). Consequently, this region is exposed to the possibility of accidents arising from oil activity.

A microbial mixture containing the following composition (w/w) was prepared: 13.6% petroleum, 13.2% crude glycerin, 3.4% castor cake, 26.6% calcined sand, 17.6 % clay mangrove sediment, 25.6% saline solution (sea water) and fungi. The mixture was stirred and heated at a temperature in the range between 70 and 90°C for about 3 minutes and then distributed in Petri dishes with lids, where the fungi *Aspergillus tamarii Kita* and *Neocosmospora solani* were subsequently sown, after sowing the microbial mixture material was left to rest for proliferation. After rest and proliferation over a period of approximately 90 days of sowing the fungi, greater proliferation and fungal concentration were observed in the superficial part of the samples, in which it developed and produced, above the spores, residues and a brightly crystallized product, colorless and transparent, square and rectangular in shape. For the characterization and identification of the products, analyzes of Granulometry, X-ray Diffraction, X-ray Fluorescence, Infrared (FTIR), Scanning Electron Microscopy (SEM), Liquid Chromatography (HPLC), among others, were used, conventional analysis techniques, extensively described in the literature and known to specialists.

The fungi Aspergillus tamarii Kita and Neocosmospora solani were used, both Microorganisms are deposited in a microorganism bank - Fundação André Tosello under nº CCT 7966, service order 200811-1 in São Paulo (Brazil). Has a Patent for Invention granted by INPI / BR PI 1105934-6 on 08/09/2022 PROCESS FOR OBTAINING BIOSENSOR AND ENZYMATIC BIOACTIVE BIOSENSOR[9]; which was adapted for this production.

3 RESULTS & DISCUSSION

The work developed a product of inorganic mineral carbon silicate particles for application in new materials and electronics. It has characteristics of carbon nanotube as observed by image of MEV/EDS crystallography (Figure 1) and Chlorine (Cl) and Carbon (C) peaks by Microscopy/SEM, among other residual elements (Table 1).

Table 1 Elemental quantitative analysis by MEV/EDS

Element	Atomic (Wt%)	Weight (%)	Standard Label
C	86.73	91.44	C Vit
O	8.4	6.65	SiO_2
Mg	0.62	0.32	MgO
Al	0.16	0.07	Al_2O_3
Si	0.66	0.30	SiO_2
S	1.82	0.72	FeS_2
Cl	0.89	0.32	NaCl
Ca	0.21	0.07	Wollastonite
Fe	0.52	0.12	Fe
Total	100	100	

In SEM a high Carbon peak stands out with 86.73 Wt%, followed by Oxygen with 8.4 Wt%, confirming the result of the dry biopolymer appears, sulfur with a peak of 1.82 Wt%. This result leads to inducing organic compound reactions, most likely the presence of protein as expected. The appearance of the crystallized transparent and shiny product shows a significant biotransformation. With that, it can be stated that the product formed is a protein with organic chemical amide compounds.

Figure 1A Shows an electron microscope photo of Halite crystals in fungal cultures in Petri dishes and in WD10mm at 500μm; Figure 1B Presents an electronic image of 25 μm of part of the crystallized product.

After 3 months in ambient temperature rest, the X-ray diffraction shows the peaks H 3.28; H 2.82; H 1.99; H 1.70; H 1.62 which characterizes main Halite Crystals. However, after this period, X-ray diffraction analysis presents peaks Qz 4.2 and Qz 3.34 that characterize secondary crystallized silica, which makes up organic/inorganic compounds. Figure 1A e 1B represents photos of semiconductor crystals.

In the characterization of organic compounds, a spectrum was obtained (Figure 2) with peaks that indicate: (a) at wavelength (cm-1) 3,600 to 2,700 the absorption of C-H, O-H and N-H atoms; (b) at wavelength peaks (cm-1) from 1,700 to 1630 C=O of amides and from 1,670 to 1,630 N, N-substituted amides presenting a single band; (c) in 1,400 C-Halogens, C-Cl, C-Br; in 1,311 SO_2; (d) in 1,347 C-O of carboxylic acids; at 1.037 S=O sulfoxide and from 698 to 472 aromatic ring, naphthalene and Halogen C-Cl, C-Br, the proteins were identified with organic amide compounds, formed by the polymerization of amino acids when analyzed by Infrared Spectroscopy with Fourrier transform (FTIR).

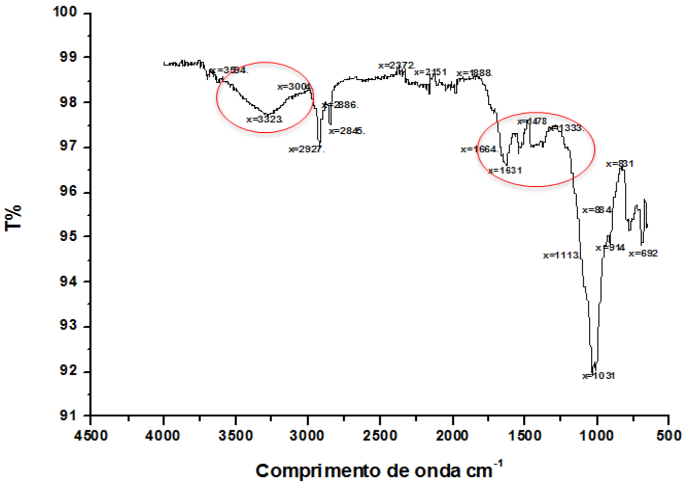

Figure 2 Infrared of residual semiconductor crystal samples with evidence of amide peaks

4 CONCLUSION

The new material described has a great potential of application in different technological areas. The organic semiconductor compounds are enclosed within the halite crystal that serves as protection. The enzyme crystal can be sterilized to remove the bioactive. When sterilized in an Autoclave sterilization instrument, the product becomes conductor polymer free of live agent, used in the most varied industries of electronics, chips, computer boards, smartphones, among others. It is a different product from those that already exist, because it is synthesized by fungi that use environmental contamination in the physical-chemical transformation, returning a totally new product capable to be used in the electronics industry with potential for technological innovation. Contamination is no longer a waste harmful to integrate with new high-tech materials with worldwide application. As the production increases that will be contributing to the health and cleanliness of the environment and living beings on the planet. Therefore, it is important that the process is publicized and developed openly so that it can cover a wide range of population of people, this is because, when put into practice, everyone will be contributing to the use of sediments from areas impacted by contaminants from the oil industries while the cleaning the environment of mangrove areas with oil spills.

This proposal shall contribute to restore the natural microbial biota, regarding the benefits arising from them that will contribute to the chain healthy diet for the human population that feeds on fish and crustaceans from marine life. It is characterized as a technological innovation because it becomes practical the greater the use of the product in semiconductor microelectronics, the greater the transformation of contaminants into raw materials, consequently environmental cleaning. There is a solution to one of the biggest global problems: environmental contamination, human health, living beings, Bioremediation of impacted marine environments. The technical team is the only one that has mastered this technology on a laboratory scale and intends to sign agreements with companies that are interested in scaling the product and commercially exploring the microelectronics sector.

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