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Polymer Based Nano-Composite Anode for Microbial Fuel Cell

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Abstract: ***MFCs convert chemical energy to electrical energy by using microorganisms. It involves bio-electrochemical reaction and considered as the green energy storage devices because of no emission of the environmental polluting gases. The properties like stability in microbial inoculums, high conductivity, large surface area etc are favourable to make MFC anodes. Nanomaterials are cheaper and their manufacturing consumes less material and energy and therefore contributes less wastes. So the objective here to use nanocomposites material as anode in microbial fuel cells (MFCs).***

Keywords: Nanomaterial, Pymer, nano- composites

1. Introduction

The demand of high amount of energy is leading to the depletion of non renewable sources of energy. The wastewater amount is increasing and MFCs can be used to generate electrical power by using the microorganisms present in the wastewater bodies. [1]

MFCs have advantages like no emission of harmful green house gases (SO2, CO2 etc.), higher efficiency, lack of sonic pollution etc.[2]

There has been an extensive growth of MFC and green energy technology in the last decade and one of the reasons for that is the availability of viable methods for the synthesis of nanocomposite based electrode material. Nano-composite based anode materials are of much use and for further enhancements the Pt-free anode electrode catalyst can be used which exhibits superior performance of the developed conversion of organic substrate into electricity through E. Coli bacteria. [3]

MFCs exploit microbial activity to generate electricity. They can be simultaneously used for wastewater treatment and bioelectricity generation. The anode is determinative for the overall performance of the MFCs. In high power output, anode is the limiting factor.[4]

2. Methodology

MFCs contain two chambers- anode and cathode- which are physically separated by a proton exchange membrane (PEM). An active microorganism is used as a biocatalyst in the anode compartment and it was filled with wastewater. This biocatalyst in anode oxidizes organic substrates and produces electrons and protons. But the oxygen in anode chamber will inhibit the production of electricity, thus to keep the bacteria separated from oxygen a system is designed which made the chamber anaerobic. The electrons and protons produced are transferred to the cathode chamber. Protons are conducted to cathode by PEM and electrons are conducted to cathode through external circuit. Protons and electrons are reacted in cathode. Since the type of anode we use, is an important factor for the overall performance of the MFCs, several anodes are used in different experiments and the results are obtained. The various nanocomposite materials used are-

2.1 Polypyrrole coated carbon nanotubes (PPy-CNTs)
2.2Polyaniline carbon nanotubes nanocomposite (CNT/PANI)
2.3 Polytetrafluoroethyline (PTFE)

3. Results and Discussion

3.1 Polypyrrole coated carbon nanotubes (PPy-CNTs)

Using PPy-CNTs, the electrochemical surface area increases. After coating with PPy-CNTs, the electron transfer resistance of the anodes reduce dramatically from 500ohms to zero. These results indicate that it increases the conductivity between electrode and electrolyte. Since the surface area of the nanocomposite materials is large, more active reaction sites are available for bacterial attachment and electrochemical reaction.

3.2 Polyaniline carbon nanotubes nanocomposites (CNT/PANI)

The results showed that the resistance of the anode tested with both bacteria and glucose present, is significantly smaller than that in the presence of bacteria but without glucose. This implies that the rate of glucose oxidation in PANI is faster. Constant current discharge tests of the three anodes show that the composite anodes could provide higher power density because of their low polarization density.

3.3 Polytetrafluoroethyline (PTFE)

It is used because of its chemical stability and hydrophobic nature. The power density produced when the graphite/PTFE composite with optimized 30% content of PTFE used was 760mW/m2.

4. Outcomes and Analysis

Using polymer based nanocomposite anode for microbial fuel cell has improved the performance of the MFCs by increasing the interactions between bacteria and anode because the polymer based nanocomposites has high conductivity and large surface area. MFCs have gained much popularity because they generate the most sustainable energy by using active biocatalysts. It helped in generating excess current from the MFCs as the capacitance is increased.

5. Epilogue

Use of MFCs is very expensive so less expensive materials can be used to reduce the cost of the microbial fuel cells. It cannot be used effectively for commercial use because the generated power is too low, so measures must be taken to increase the generated power.

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