A study on quantum dot NPs for drug delivery

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Abstract

Quantum dots (QD) are semiconductor particles with sizes of a few nm. QD emit light of a specific wavelength when a current is applied or exposed to light. Quantum dot nanocrystals are semiconductor nanomaterials with intrinsic chemical and physical properties. Quantum dots are also being used in place of organic dyes in biological research; for example, they can be used like nanoscopic light bulbs to light up and color specific cells that need to be studied under a microscope. They're also being tested as sensors for chemical and biological warfare agents such as anthrax. Quantum dots (QDs) are semiconductor particles a few nanometres in size, having optical and electronic properties that differ from larger particles due to quantum mechanics. They are a central topic in nanotechnology. Currently, quantum dots are used for labeling live biological material in vitro and in vivo in animals (other than humans) for research purposes - they can be injected into cells or attached to proteins in order to track, label or identify specific bio molecules.

Keywords:. Quantum dots, Semiconductor particles, organic dyes, bioimaging, solar cells, LEDs, diode lasers, and transistors, Plasma synthesis

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I. Introduction

Quantum dots are widely used for their unique optical properties, as they emit light of specific wavelengths if energy is applied to them. These wavelengths of light can be accurately tuned by changing various properties of the particle, including shape, material composition, and size. Quantum dots (QDs) are often referred to very tiny man-made semiconductor particles, whose size are normally no more than 10 nanometers. Their extremely small size renders their optical and electronic properties different from those of bulk materials. A majority of QDs have the ability to emit light of specific wavelengths if excited by light or electricity. According to existing literature, the electronic characteristics of QDs are determined by their size and shape, which means we can control their emission wavelengths by tuning their size. Typically, smaller QDs (e.g., radius of 2~3 nm) emit shorter wavelengths generating colors such as violet, blue or green. While bigger QDs (e.g., radius of 5~6 nm) emit longer wavelengths generating colors like yellow, orange or red. Their highly tunable optical properties based on their size are fascinating, leading to a variety of research and commercial applications including bioimaging, solar cells, LEDs, diode lasers, and transistors.

II. Methodology

Fig.1 Quantum dots NPs

A quantum dot is a nanometer-sized semiconductor particle traditionally with a core-shell structure. Quantum dots are widely used for their unique optical properties, as they emit light of specific wavelengths if energy is applied to them. These wavelengths of light can be accurately tuned by changing various properties of the particle, including shape, material composition, and size.

II.A Quantum Dot Production

There are various methods of producing quantum dots. The most typical is via a colloidal synthesis, which is the process of heating a solution, causing the precursors to decompose to form monomers, which then produce nanocrystals. Quantum dots produced using this method can consist of compounds including indium arsenide, lead sulfide, lead selenide, and cadmium sulfide. Colloidal synthesis is a popular method as quantum dots can be produced in batches large enough to be potentially used for commercial applications. Plasma synthesis is another popular technique for the production of quantum dots. This process enables the control of the composition, surface, size, and shape of the quantum dot, and it also reduces the challenges associated with doping.

II.B Working Principle of a Quantum Dot (QD)

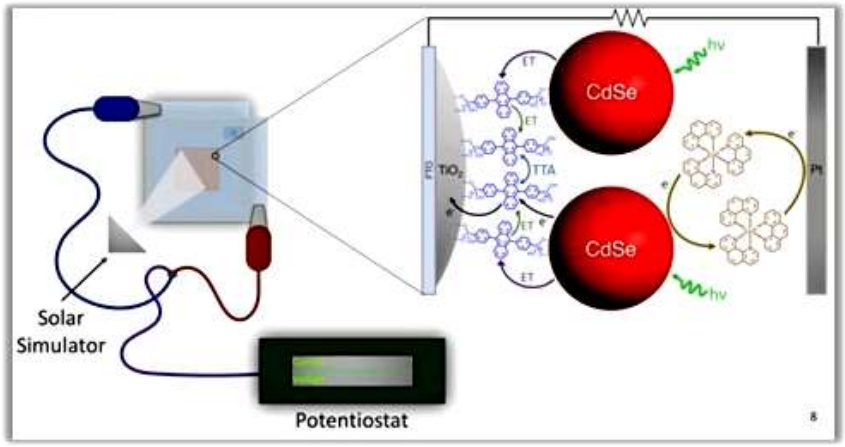
Within a quantum dot, there are confined valence band holes, conduction band electrons, or excitons. These are the particles that carry the electricity, and because of this confinement, the quantum dot has a distinct energy level. The electrons within a quantum dot have to occupy an energy level that 'fits' inside it, and when excitation occurs these electrons emit a photon. Excitation can be caused by the quantum dot coming into contact with a light or electricity source. The longest wavelengths of light (red light) are produced by the biggest quantum dots, and the shortest wavelengths of light (blue light) are generated by the smallest quantum dots.

II.C Quantum Dot Applications

Quantum dots are proving to be a very promising solution for a range of optical applications, due to their outstanding properties. One of the most typical applications is for displays, including televisions, and smart phones. Quantum dots provide greatly enhanced colors for displays due to the high level of fine-tuning possible. They also help to improve quality control of displays, reducing the risk of variations.

II.D CdSe Quantum

CD Bio particles provides cadmium selenide (CdSe) semiconductor quantum dots with size-dependent emission range. Our CdSe quantum dots are core type II–VI semiconductor materials with size dependent optical/electronic properties, uniform size distribution and high quantum yield. The outer surface coating of organic ligands of CdSe quantum dots can be changed by ligand exchange process. CdSe quantum dots can be used in highly sensitive cellular imaging, drug delivery and light emitting devices.



II.E Applications:

- Highly sensitive cellular imaging
- Photovoltaic devices
- Drug delivery
- Solar cells
- Light emitting devices
- Photoresistors

III. F How do quantum dot solar cells work?

The light rays enter through the transparent electrode of a quantum dot solar cell onto a light absorbing layer of dots in order to generate electron hole pairs. The charged particles then separate and eventually travel to their respective electrodes, producing electric current.

II.G How are quantum dots prepared?

Quantum dots can be manufactured by a number of processes from colloidal synthesis to chemical vapour deposition (CVD). The cheapest and simplest method is benchtop colloidal synthesis. Electrochemical techniques and CVD can be used to create ordered arrays of quantum dots on a substrate material.

II. H What is quantum dot sensitized solar cells?

Quantum Dot Sensitized Solar Cells are considered as the potential third generation solar cells due to their suitable optoelectronic properties for photovoltaic response. Quantum dot sensitized solar cells are showing power conversion efficiencies up to 12%, very close to its counterpart dye sensitized solar cells.

II.I Are quantum dots toxic?

Cell culture experiments demonstrate that quantum dots (QD) induce **cytotoxicity** via two mechanisms: (A) QD degradation with release of free cadmium and (B) Generation of reactive oxygen species. These mechanisms likely combine to cause toxicity.

II.J What do quantum dots look like?

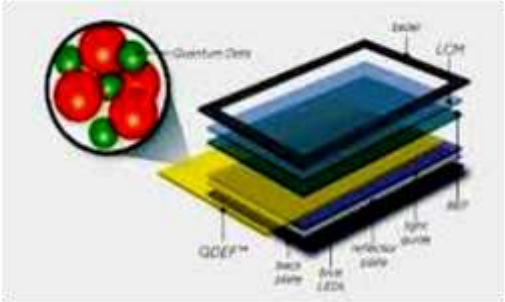


Fig. Outline of the quqantum dots

Quantum dots are tiny, and their size determines their color. There are two sizes of dots in these TVs. The “big” ones glow red, and they have a diameter of about 50 atoms. The smaller ones, which glow green, have a diameter of about 30 atoms.

II.K What are quantum dots discuss any two properties of quantum dots?

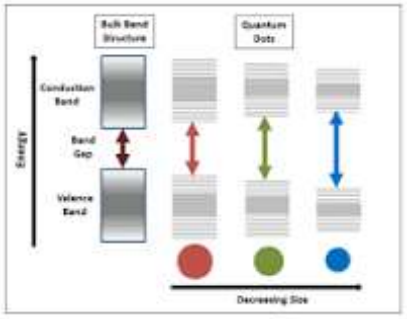


Fig. Two properties of quantum dots

The emission wavelengths of QDs span from the ultraviolet (UV) to the infrared (IR). Other properties of QDs include high quantum yield, high photostability, and high molar extinction coefficients. Their emissions are also relatively narrow and symmetrical at specific wavelengths.

III.Results and discussion

The difference is not in the size, is in the properties. All quantum dots are nanoparticles, but not all nanoparticles are quantum dots. Quantum dots (QDs) are man-made nanoscale crystals that can transport electrons. Nanoparticles (NPs) are also very small structures but larger than QDs, usually ranging from 8 to 100 nanometers. Because of this, NPs exhibit behaviors between those bulk materials and atoms or molecules.The smallest quantum dot emits blue light and the largest emits red. The peak emissions of quantum dots can be tuned to within 1 nm giving excellent control over the colour spectrum output of displays. The colour produced by quantum dots (QD) is dependent on the size of the particle ranging from 2nm to 6nm.The advantages such as better color accuracy, higher color saturation, possibly wider contrast ratio, and higher peak brightness have made quantum dot technology ideal for producing displays capable of ultra-high definition.Nanometer-sized crystals, often referred to as quantum dots (QDs), have been also intensively investigated. Typical QD sizes range between 2–20 nm [3], but according to some literature their diameter should be strictly below 10 nm [4-5]. However, the dimensions of QDs depend mainly on the material used to prepare them. We can summarize the predicted advantages of QD-lasers as [12]: 1. Emits light at wavelengths determined by the energy levels of the dots, rather than the band gap energy. Thus, they offer the possibility of improved device performance and increased flexibility to adjust the wavelength [13].

IV. Conclussions

Quantum dots (QDs) are semiconductor nanoparticles which exhibit size and composition-dependent optical and electronic (optoelectronic) properties. QDs are ultrasmall, typically falling in the size range between 1.5 and 10.0 nm.A layer of quantum dots is sandwiched between layers of electron-transporting and hole-transporting organic materials. An applied electric field causes electrons and holes to move into the quantum dot layer, where they are captured in the quantum dot and recombine, emitting photons.Quantum dots (QDs) are man-made nanoscale crystals that that can transport electrons.QDs are spherical, fluorescent nanocrystals of semiconductor materials with a diameter of 2–8 nm. They exhibit distinctive properties like narrow and broad emission spectra, negligible photo bleaching, high sensitivity, and stable fluorescence with simple excitation without the need for laser [25].

References

1. Khan KA (1999) Copper oxide coatings for use in a linear solar Fresnel reflecting concentrating collector, Published in the journal. of Elsevier, Renewable Energy, An International Journal, WREN(World Renewable Energy Network), UK, RE: 12.97/859,1998, Publication date 1999/8/1, J. Renewable energy, 17(4) :603-608. Publisher - Pergamon, 1999
2. T.A. Ruhane, M.Tauhidul Islam, Md. Saifur Rahman, M.M.H.Bhuiyah, Jahid M.M. Islam, T.I. Bhuiyah, K.A.Khan , Mubarak A. Khan(2017) Impact of photo electrode thickness annealing temperature on natural dye sensitized solar cell, Sustainable Energy Technologies and Assessments, Elsevier, http://dx.doi.org/10.1016/j.seta.2017.01.012
3. T.A. Ruhane, M. Tauhidul Islam, Md. Saifur Rahaman, M.M.H. Bhuiyan, Jahid M.M. Islam, M.K. Newaz, K.A. Khan, Mubarak A. Khan(2017) Photo current enhancement of natural dye sensitized solar cell by optimizing dye extraction and its loading period, Optik - International Journal for Light and Electron Optics, Elsevier
4. Mehedi Hasan & K. A. Khan (2018) Dynamic model of Bryophyllum pinnatum leaf fueled BPL cell: a possible alternate source of electricity at the off-grid region in Bangladesh, Microsystem Technologies Micro - and Nanosystems Information Storage and Processing Systems, Springer, ISSN 0946-7076, Microsyst Technol DOI 10.1007/s00542-018-4149-y
5. K. A. Khan, M. Hazrat Ali, A. K. M. Obaydullah & M. A. Wadud(2019) Production of candle using solar thermal technology, Microsystem Technologies Micro- and Nanosystems Information Storage and Processing Systems, Springer, ISSN 0946-7076, Microsyst Technol, 25(12), DOI 10.1007/s00542-019-04390-7
6. K. A. Khan, S. R. Rasel & M. Ohiduzzaman(2019) Homemade PKL electricity generation for use in DC fan at remote areas, Microsystem Technologies Micro- and Nanosystems Information Storage and Processing Systems, ISSN 0946-7076, Microsyst Technology, 25(12), DOI 10.1007/s00542-019-04422-2
7. Mehedi Hasan & Kamrul Alam Khan (2019) Experimental characterization and identification of cell parameters in a BPL electrochemical device, Springer, SN Applied Sciences (2019) 1:1008 | https://doi.org/10.1007/s42452-019-1045-8
8. Lovelu Hassan and K. A. Khan (2019) A study on harvesting of PKL electricity, Springer Journal, Microsyst Technol (2020) 26:1031-1041 DOI 10.1007/s00542-019-04625-7, 26(3),PP:1032-1041.
9. K. A. Khan, M. A. Mamun, M. Ibrahim, M. Hasan, M. Ohiduzzaman, A. K. M. Obaydullah, M. A. Wadud, M. Shajahan(2019) PKL electrochemical cell: physics and chemistry, Springer Journal, SN Applied Sciences (2019) 1:1335 | https://doi.org/10.1007/s42452-019-1363-x
10. M.Hazrat Ali, Unesco Chakma,Debashis Howlader, M. Tawhidul Islam and K.A.Khan (2019) Studies on Performance Parametersof a Practical Transformer for Various Utilizations, Microsystem Technologies, Springer, Accepted:03 Dec 2019, DOI: 10.1007/s00542-019-04711-w
11. Khan, K.A., Hassan, L., Obaydullah, A.K.M. et al. Bioelectricity: a new approach to provide the electrical power from vegetative and fruits at off-grid region. Microsyst Technol (2018). https://doi.org/10.1007/s00542-018-3808-3
12. Khan KA, Bhuyan MS., Mamun M A., Ibrahim M., Hasan L., Wadud M.A.(2018), Organic Electricity from Zn/Cu-PKL Electrochemical Cell, In: Contemporary Advances in Innovative and Applicable Information Technology, Advances in Intelligent Systems and Computing, J. K. Mandal et al. (eds.), © Springer Nature Singapore Pvt. Ltd., 2018, Vol. 812, Chapter 9, p 75-90.

13. AKMAtiqueUllah,MdMahbubulHaque,MahmudaAkter4,AHossain,ANTamanna,Md.MottalebHosen,AKMFazleKibria, MNIKhanandMKAKhan(2020)GreensynthesisofBryophyllumpinnatumaqueousleafextractmediatedbiomoleculecappeddiluteferromagneticα-MnO2 nanoparticles, Mater.Res.Express7(1)(2020),015088, IOP publishing Ltd.

14. K.A.Khan, M Hazrat Ali, M. A. Mamun, M. Mahbubul Haque, A.K.M. Atique Ullah, M.N. Islam Khan, Lovelu Hassan, A.K.M. Obaydullah, M.A.Wadud (2020), Bioelectrical Characterization and Production of Nanoparticles (NPs) Using PKL Extract for Electricity Generation, Received: 31 July 2018/Accepted: 4 February 2020, Microsystems Technology, Springer Journal, DOI 10.1007/s00542-020-04774-0.
15. K.A. Khan (2002) Prospect of Solar Energy for Food Supply in Bangladesh. Bangladesh J. of Scientific and Industrial Research BJSIR, 37(1-4)
16. Sen BK., Khan KA, Khan MAH, Awal MA(2001) Studies on Optical & thermal properties of black copper solar selective coating on copper substance. Jahang. Phys. Studs. Department of Physics, Jahangirnagar University, Savar, Dhaka, Bangladesh, Vol. 9
17. Ahsan MN, Sen BK, Khan KA & Khan MAH(1999) Performance of a Low Cost Built-in-storage Solar Water Heater. Nuclear Science and Applications, 8(1-2):
18. Khan AJ, Khan KA, Mahmood ZH & Hossain M(1991) Performance of an Intermittently Tracked Linear Solar Fresnel Reflecting Concentrator. The Dhaka University studies, part B (science) vol. 39(2):
19. Khan KA, Khan AJ & Rabbani KS (1998) Design & performance studies of a Linear Fresnel Reflecting Solar Concentrator-Receiver System, Bangladesh J.Sci. Res. 16 (2):143-146
20. Islam S, Khan KA, Islam AKS & Ali MJ(2000) Design, Fabrication & performance study of a Paraboloidal Solar Medical Sterilizer. Bangladesh J.Sci. Res. 18(2): 211-216
21. K.A. Khan (1998) Solar Selective Coating for use in Solar Concentrating Collector Bangladesh J. Sci. Res. 16(2) pp: 249-252
22. K.A. Khan (1999) The performance of a Fresnel Reflecting Concentrating Collector with Auxiliary Heating Bangladesh J. Sci. Ind. Res. 34(2)
23. K.A. Khan (1998) Production of Candles by Solar System in Bangladesh. Nuclear Science & Applications: 7(1-2):
24. K.A. Khan (1997) Field Testing of a Fresnel Reflecting Solar Concentrator, Nuclear Science & Applications. AEC, Dhanka, Bangladesh, 6(1-2):
25. K.A. Khan, Khan AJ & Rabbani KS(1998) Solar Thermal Steam Production & Distillation Device by Fresnel Reflecting Concentrator – Receiver System, Bangladesh J. Sci. Res. 16(2): 221-228.
26. K.A. Khan (2008) Studies on Electricity Generation from Stone Chips Plant (Bryophyllum pinnatum), Int: J.Eng. Tech 5(4): 393-397
27. Islam MS and K.A. Khan (2008) Performance Studies on Single Crystal Solar PV Modules for Practical Utilisation in Bangladesh. Int: J.Eng. Tech 5(3): 348-3528
28. K.A. Khan (2008) Studies on Fill Factor(FF) of Single Crystal Solar PV Modules For Use In Bangladesh. Int: J.Eng. Tech 5(3): 328-334
29. K.A. Khan (2008) Performance Studies of Monocrystallinne PV module considering the shadow effect. Int: J.Eng. Tech 5(3): 342-347
30. MS I and K.A. Khan (2008) Study the Deterioration of a Monocrystal Solar silicon PV module Under Bangladesh Climate. Int: J.Eng. Tech 5(2):26 3-268
31. Hassan SJ and K.A. Khan (2008) Design, Fabrication and Performance Study of a Single phase Inverter for use in Solar PV system. Int: J.Eng. Tech 5(1):212-216
32. K.A. Khan (2009) Soap Production Using Solar Power. Int: J. Eng. Tech 6(1):414-419
33. K.A. Khan (2009) Wave and Tidal Power Generation: An Overview. Int: J. Eng. Tech 6(1):420-423, March 2009
34. K.A. Khan (2009) .Materials Used in Electricity Generation by Solar Thermal System
35. International J. Eng. Tech 6(1):515-520, June 2009
36. K.A. Khan (2009) Comparative Study on Single Crystal and Polycrystalline solar pv modules for use in Bangladesh climate. Int: J. Eng. Tech 6(1):527-529
37. K.A. Khan (2009) Electricity Generation From Pathor Kuchi Leaf(Bryophyllum Pinnatum). Int.J.Sustain.Agril.Tech.5(7):80-84.
38. K.A. Khan (2009) Community Pathor Kuchi Leaf (PKL) Electricity Generation System. Int: J.Sustain.Agril.Tech.5(6):71-73
39. K.A. Khan (2009) Solar Thermal Studies Of Open Sun Drying (OSD) of Various Crops Under Bangladesh Climatic Condition. Int: J. Sustain. Agril. Tech. 5(7): 85-94.
40. K.A. Khan (2009) An Investigation on Various Solar Cells Under the Climatic Condition of Bangladesh. Int: J. Eng. Tech. 6(3): 547-551, September 2009
41. K.A. Khan and Alam MM (2010) Performance of PKL (Pathor Kuchi Leaf) Electricity and its Uses in Bangladesh. Int. J. SOC. Dev. Inf. Syst. 1(1): 15-20

42. K.A. Khan and Alam MM (2010) Comparative Study of Solar Home System and Pathor Kuchi Leaf Home System with Light Emitting Diode. Int. J. Sustain. Agril. Tech. 5(6): 74-79
43. K.A. Khan and Arafat ME (2010) Development of Portable PKL (Pathor Kuchi Leaf) Lantern. Int. J. SOC. Dev. Inf. Syst. 1(1):
44. K.A. Khan and Bosu R (2010) Performance study on PKL Electricity for Using DC Fan. Int. J. SOC. Dev. Inf. Syst. 1(1): 27-30
45. K.A. Khan and Hossain MI(2010) PKL Electricity for Switching on the Television and Radio. Int. J. SOC. Dev. Inf. Syst. 1(1): 31-36
46. K.A. Khan and Islam MS(2010) Studies on Performance of Solar Photovoltaic System Under the Climate Condition of Bangladesh. Int: J. SOC. Dev. Inf. Syst. 1(1): 37-43
47. Khan KA , Wadud MA, Obaydullah AKM and Mamun MA(2018) PKL (Bryophyllum Pinnatum) electricity for practical utilization. IJARIIE-ISSN(O)-2395-4396, 4(1): 957-966
48. K.A. Khan (2009) Application of Solar Thermal Technology for Various Developing Countries. Int: J. Eng. Tech. 6(6):
49. Saifuddin SM & K.A. Khan (2010) Performance Study of Hybrid SPV, ST and BPL/PKL electricity Generation and storage for Practical Utilization in Bangladesh. Int: J. Eng. Tech : ISSN 1812 – 7711, 7(2)
50. Saifuddin SM & K.A. Khan (2010) Survey of Hybrid Solar Photovoltaic (SPV) and Solar Thermal (ST) Collectors in Bangladesh. Int: J. Eng. Tech : ISSN 1812 – 7711, 7(3)
51. Saifuddin SM & K.A. Khan (2010) Performance Study of Solar Photovoltaic and Solar Thermal Hybrid System Utilized in India. Int: J. Soc. Dev. Inf. Syst. 1 (4) : 10 – 16
52. K.A. Khan (2010) Organic Electricity Generation, Storage and Utilization by PKL (Bryophillum Pinnatum). Int: Journal of Social Development and Information system(IJSDIS).1(6):
53. Sultana J, Khan KA and Ahmed MU(2010) Present situation of Solar Photovoltaic System in different countries. ASA University Review, 4(2) ISSN:1997-6925
54. Rahman AA and K.A. Khan (2011) The Present situation of the Wave energy in some different countries of the world. IJCIT, ISSN 2078 5828(print),ISSN 2218-5224(online),2(1) Manuscript code:110754
55. Hasnat A,Ahmed P,Rahman M and Khan KA(2011) Numerical Analysis for Thermal Design of a Paraboloidal Solar Concentrating Collector. Int: Journal of Natural Sciences(2011),1(3): 68-74
56. K.A. Khan & Rubel AH(2011) Simulated Energy Scenarios of the Power Sector in Bangladesh. ASA University Review, 5(2): 101-110, ISSN:1997-6925
57. Sultana J, Khan KA and Ahmed MU(2011) Studies on Hybrid Pathor Kuchi Leaf (PKL)/Bryophyllum Pinnatum Leaf(BPL) and Solar Photovoltaic Electricity Generation. J.Asiat.Soc.Bangladesh.Sci.,37(2):181-188,
58. Sultana J, Khan KA and Ahmed MU(2011) Electricity Generation from Pathor Kuchi Leaf(Bryophyllum Pinnatum). J.Asiat.Soc.Bangladesh.Sci.,37(2):167-179
59. Rashid MA, Rashed-Al-Mamun RA, Sultana J, Hasnat A, Rahman M and Khan KA (2012) Evaluating the Solar Radiation System under the Climatic Condition of Bangladesh and Computing the Angstrom Coefficients, International Journal of Natural Sciences . 2(1):38- 42. Received: November 2011, Accepted: March 28, 2012.
60. Sultana J, Khan KA and Ahmed MU(2012) The Present Situation of Solar Thermal Energy in the World. ASA University Review, 4(2), ISSN:1997-6925
61. Paul S, Khan KA, Islam KA, Islam B and Reza MA(2012) Modeling of a Biomass Energy based (BPL) Generating Power Plant and its features in comparison with other generating Plants. IPCBEE vol. 44 (2012) @ (2012) IACSIT Press, Singapore, DOI: 10.7763/ IPCBEE. 44(3):
62. K.A. Khan, Paul S, Zishan SR, Abidullah M, Mahmud S(2012) Design of a Hybrid Model of BPL Electricity Module and Solar Photovoltaic Cell. Int: J. of Sci. Eng. Research. 3(12), ISSN 2229-5518.
63. K.A. Khan, Paul S, Zishan SR, Abidullah M, Mahmud S(2012) A Study on Tidal Power Conversion for Use in Bangladesh. Int: J. of Sci. Eng. Research. 3(12), ISSN 2229-5518.
64. Bhuiyan MSA, Khan KA and Jabed MA(2012) A Computerized study on the metrological parameter conversions for rural agribusiness development. J.of Innovation & Development Strategy (JIDS) (J. Innov. Dev. Strategy) J. Innov. Dev. Strategy 6(2):94-98
65. K.A. Khan, Paul S, Zobayer A, Hossain SS(2013) A Study on Solar Photovoltaic Conversion. Int:J. of Sci. and Eng. Research , 4(3), ISSN2229-5518
66. K.A. Khan, Shuva Paul, Abdullah M, Sifat SM and Yousufe MR (2013) Performance Analysis of BPL/PKL Electricity Module. Int:J. of Sci. and Eng. Research, 4(3),ISSN2229-5518
67. K.A. Khan, Paul S, Zobayer A, Hossain SS(2013) A Study on Solar Thermal Conversion. Int:J. of Sci. and Eng. Research, 4(3),ISSN2229-5518

68. Bhuiyan MSA and Khan KA(2013) Software Development Studies on the Metrological Conversions for Local Agri-Business Units of Area and Volume Weight Measures. J. of Innovation & Development Strategy (JIDS), Canada, 7(1): ISSN 1997-2571
69. Ahsan MM, Kumar S, K.A. Khan, Khanam MN, Khatun R, Akter S, Aheikh MAR, Islam MM, Islam MS, Saha S and Alam MM(2013) Study of Spatial Resolution of a Positron Emission Tomography(PET) System. Jagannath University Journal of Science, 2(1),ISSN 2224 – 1698.
70. Paul S, Khan KA and Asaduzzaman (2013) A Analytical Study on Electro chemistry for PKL (Pathor Kuchi Leaf) Electricity Generation System. Published in the Proceedings of IEEE, ENERGYTECH 2013, USA. [Participated and Presented in the "EnergyTech2013Conference sponsored by the Institute of Electrical and Electronic Engineers(IEEE) at Case Western Reserve University in Cleveland, Ohio, USA, 21 May - 23 May, 2013, USA.]
71. Paul S, Khan KA and Kundu RK(2013) Design, Fabrication and Performance Analysis of Solar Inverter. Published in the Proceedings of IEEE, ENERGYTECH 2013, USA. [Participated and Presented in the "EnergyTech2013Conference sponsored by the Institute of Electrical and Electronic Engineers(IEEE) at Case Western Reserve University in Cleveland, Ohio, USA, 21 may-23 May ,2013, USA.]
72. Paul S, Khan KA and Ripon Kumar Kundu RK (2013) Performance Studies of Mono-Crystal Silicon Solar Photovoltaic module with booster reflector under Bangladeshi Climatic condition. Published in the Proceedings of IEEE, ENERGYTECH 2013, USA. [Participated and Presented in the "EnergyTech2013Conference sponsored by the Institute of Electrical and Electronic Engineers(IEEE) at Case Western Reserve University in Cleveland, Ohio, USA, 21 May-23 May ,2013, USA.]
73. Rahman AA and K.A. Khan (2013) Feasibility Studies on WEC (Wave Energy Converter) for use in Coastal Belt at Cox's Bazar of Bangladesh under the Climate Condition of the Bay of Bengal.Int: J. of Engi. and Innovative Technology,3660 East Bay Drive, Apartment no.116 Largo, Florida US,33771 (IMPACT FACTOR:1.895) (ISO 9001:2008 Certified)
74. Hossain M , Alam S and Khan KA (2013) A study on low power generation from Pathor Kuchi Leaf (Bryophyllum) for practical utilization in Bangladesh. Int: J. of Engi. and Innovative Technology,3660 East Bay Drive, Apartment no.116 Largo, Florida US,33771 (ISO 9001:2008 Certified)
75. Bakshi M and Khan KA(2014) "Electricity Generation from Bryophyllum Pinnatum Leaf (BPL)-An Innovative approach for both Physicist and Chemist". J. of Int: Organization of Sci. Research (IOSR) Review Report (Article id: F42028)
76. Khan KA, Latif A, Alam A, Sultana J and Ali H(2014) A Study on Internal Resistance of the Pathor Kuchi Leaf (PKL) Cell. J. of Agriculture and Environment. 10(1):24-28.
77. Ahasan MN, Quadir DA, Khan KA and Haque MS (2014) Simulation of a thunderstorm event over Bangladesh using wrf-arw model. J. of Mechanical Engineering, 44(2) Transaction of the Mechanical Engineering Division, The Institute of Engineers, Bangladesh.
78. Khan KA, Sultana J, Latif MA, Mamun MA and Saime MA (2014) A new approach of increasing the power output of Pathor Kuchi Leaf (PKL) Cell. J.ournal of Agriculture and Environment.10(2):15-19
79. K.A. Khan, Bakshi MH, Mahmud AA (2014) Bryophyllum Pinnatum leaf (BPL) is an eternal source of renewable electrical energy for future world. J. of American Journal of Physical Chemistry3(5):77-83, Published online November 10, 2014(http://www.sciencepublishinggroup.com/j/ajpc) doi:10.11648/j.ajpc.20140305.15 ISSN: 2327-2430 (Print); ISSN: 2327-2449 (Online)
80. Uddin MK, K.A. Khan, Sobhan MA, Ahmed F and Nabi MN(2015) On the Implications of Dynamic Wireless Spectrum Management Canons Issues in Uncertainty Use of Cognitive Radio Published in the journal of the Bangladesh Electronics Society Journal (BESJ),15(1-2):17-24
81. Uddin MK, K.A. Khan, Ahmed F and Nabi MN(2015) A Concept of Potential Radio Spectrum Administration Seeking Easy Access Spectrum (EAS) Paradigm Figured on Signal to Interference Noise Ratio (SINR) and Interference Thresholds. J. of the Bangladesh Journal of Scientific and Industrial Research, 2015 (in Review).
82. Uddin MK, K.A. Khan, Sobhan MA, Ahmed F and Nabi MN(2015) Dispensation of Commons Radio Spectrum Management Framework Issues in Implementation: Challenges and Opportunities. J. of Electronic Engineering, 2015 (in Review)
83. Uddin MK, K.A. Khan, Sobhan MA, Ahmed F and Nabi MN(2015) Dispensation of Commons Radio Spectrum Management Using Conceptual Benefit and Cost Analysis Framework Issues in Bangladesh. J. of the Chittagong University Journal of Science, 2015 (in Press)

84. Shamsuzzama M, Sikder S, Siddiqua T, Rahman MS, Bhuiyan MMH, Khan KA, and Paul D(2015) Standardization of Gamma Radiation Field for Characterizing Radiation Detecting Instrument at SSDL facilities in Bangladesh. J. of the Bangladesh Journal of Physics (BJP),18: 65-72, ISSN No.: 1816-1081, BPS.
85. Kabir MU, Sobhan MA, K.A. Khan, Khan MAR(2015) Broad Network Wide Statistics of TCP Indicator Measurements to Reassume the Status of the Wireless 3G Network Monitoring. Journal of the Journal of the University of Information Technology and Sciences (UITS) Journal. 4(2), ISSN: 2226-3128
86. Khan KA, Islam F, Guha B, Hassan ML and Mostofa MM (2015) Studies on Discharge Characteristics and Temperature effect of PKL (Pathor Kuchi Leaf) Cell. J. of " Bangladesh J. of Agriculture and Environment". 11(2):07-12
87. Sruti RN, Islam MM, Rana MM, Bhuiyan MMH, Khan KA, Newaz MK and Ahmed MS (2015) Measurement of Percentage Depth of a Linear Accelerator for 6 MV and 10 MV Photon Energies.J. of Nuclear Science and Applications, AEC, Dhaka, Bangladesh, 24(1-2):29-32.
88. Uddin MK, Sobhan MMA, Ahmed F, K.A. Khan and Nabi MN(2025) A potential Electrical and Electronic Debris Management Model and Ecological Impact and Awareness Issues in Bangladesh. Journal of the National University J. of Science. 2(1), ISSN: 1994-7763
89. Akter T, Rubel A, Ahsan M, Mamun MA and Khan KA (2016) A Comparative study on PKL (Bryophyllum Pinnatum), Aloe Vera, Lemon and Tomato juice for Electricity Generation, Int: J. of Sci. and Eng. Research (IJSER) - ISSN 2229-5518) 7(11):
90. Hasan MM, K.A. Khan, Rahman MN and Islam MZ (2016) Sustainable Electricity Generation at the coastal areas and the Islands of Bangladesh Using Biomass Resource. J. of City University, 2(1): pp 09-13
91. Kabir MU, Ahmed F, Sobhan DMA and K.A. Khan (2016) Dispensation of Commons Radio Spectrum Management Framework Issues in Implementation: Challenges and Opportunities. J. of the Bangladesh Electronic Society (BES), (ISSN: 1816-1510), 16(1-2):
92. K.A. Khan, Paul S,Rahman MS,Kundu RK, Hasan MM,Muniruzzaman M and Mamun MA(2016) A study of performance analysis of PKL electricity generation parameters:(An experimental analysis on voltage regulation, capacity and energy efficiency of pathor kuchi leaf (PKL) electricity cell). Power India International Conference (PIICON), 7th, 25-27 Nov. 2016, IEEE , Bikaner, Rajasthan, India.
93. Khan KA, Alam MS, Mamun MA, Saime MA & Kamal MM(2016) Studies on electrochemistry for Pathor Kuchi Leaf Power System, J. of Bangladesh J. Agric. And Envirin. 12(1): 37-42
94. Akter T, Bhuiyan MH, Khan KA and Khan MH(2017) Impact of photo electrode thickness and annealing temperature on natural dye sensitized solar cell. J. of Elsevier. Ms. Ref. No.: SETA-D-16-00324R2
95. K.A. Khan (2017) Performance evaluation of Vegetative and fruits Zn/Cu based electrochemical cell. Abstract published and Presented in the APS April meeting,January 28-31,2017, Session T1(Page No.: 200), Washington DC, USA. Bulletin of the American Physical Society, 62(1):
96. K.A. Khan (2017) Performance of electricity generation from Bryophyllum Leaf for Practical Utilization, Abstract published and Presented in the APS April meeting, January 28-31,2017, Session T1(Page No.: 201), Washington DC, USA. Bulletin of the American Physical Society. 62(1):
97. Mamun MA, Khan MI, K.A. Khan, Shajahan M(2017) A study on the Performance and electrochemistry of Bryophyllum Pinnutum Leaf (BPL) electrochemical cell. Abstract published and Presented in the APS April meeting, January 28-31,2017, Session T1(Page No.: 201), Washington DC, USA. Bulletin of the American Physical Society, 62(1):
98. Khan KA, Alam MS ,Rahman M, Mamun MA and Kamal MM(2017) Studies on energy efficiency for PKL (Pathor Kuchi Leaf) Power System. Bangladesh J. of Agriculture and Environment. Paper Code: BJAE/15/280
99. Khan KA, Hasan L and IIslam A(2017) Electricity Production from Vegetative and fruits. 4th Int: conference on Microelectronics, Circuits and Systems, June 3rd - 4th ,2017, Darjeeling, West Bengal, India.
100. Hasan M, Khan KA and Mamun MA(2017) An Estimation of the Extractable Electrical Energy from Bryophyllum pinnatum Leaf. American Int: J.of Research in Science, Technology, Engineering & Mathematics,ISSN (Print): 2328-3491, ISSN (Online): 2328-3580, ISSN (CD-ROM): 2328-3629
101. Hasan M, Hassan L, Haque S, Rahman M, Khan KA(2017) A study to analyze the self-discharge characteristics of Bryophyllum pinnatum leaf fueled bpl test cell. J.of IJRET, 6(8):
102. Asrafusjaman M, Akter T, Hasan M, Mamun MA and Khan KA (2017) A Comparative study on the Effect of Sodium Chloride as a Secondary Salt use in PKL(Scientific name- Bryophyllum pinnatum) and Lemon Juice for Electricity Generation. Thirty-Second Int: Conference on Solid Waste Technology and Management , Philadelphia, PA U.S.A

103. Ruhane TA, M. Islam MT, Rahaman MS, Bhuiyan MMH, IslamJMM , Newaz MK, Khan KA, Khan MA(2017) Photo current enhancement of natural dye sensitized solar cell by optimizing dye extraction and its loading period. J. of Elsevier Optik- Int: J. for Light and Electron Optics, Available online 6 September 2017
104. Khan KA, and Hossain MS(2017) Development of 1 KW PKL mini power plant for practical utilization at the off-grid region. National conference (2 days) on Science, Technology & Environment: Prospects and Limitations in the 21st Century(NCSTEPL-2017),Organised by Venue: (B.B Engg College, Assam) Bineswar Brahma Engineering College (A Govt of Assam Institution), Chandrapara, Kokrajhar-783370, Assam, (30 & 31 October)
105. Hasan M, Hassan L, Haque S, Rahman M, Khan KA(2017) A Study to Analyze the Self-Discharge Characteristics of Bryophyllum Pinnatum Leaf Fueled BPL Test Cell. Journal of IJRET, 6 (12): (with paper id 20170609104.)
106. Hasan M, Haque S, & Khan KA (2016) An Experimental Study on the Coulombic Efficiency of Bryophyllum pinnatum Leaf Generated BPL Cell. IJARIIE-ISSN(o)-2395-4396,2(1):
107. K.A. Khan; Rahman MS ; Das T; Ahmed MN; Saha KN; Paul S(2017) Investigation on parameters performance of Zn/Cu electrodes of PKL, AVL, Tomato and Lemon juice based electrochemical cells: A comparative study. Published in the Electrical Information and Communication Technology (EICT), 2017 3rd International Conference on IEEE Xplore: 01 February 2018, DOI: 10.1109/EICT.2017.8275150 Publisher: IEEE Conference Location: Khulna, Bangladesh.
108. Hossain MA, K.A. Khan, Quayum ME(2017) Performance development of bio-voltaic cell from arum leaf extract electrolytes using zn/cu electrodes and investigation of their electrochemical performance. Int:l J. of Advances in Science Engineering and Technology, ISSN: 2321-9009, 5(4):, Spl. Issue-1 Nov.-2017.
109. Hassan SJ & Khan KA (2007) Determination of Optimum Tilt angles of Photovoltaic panels in Dhaka, Bangladesh. Int: J. Eng. Trach 4 (3): 139-142
110. K.A. Khan, Rahman MS,Das T,Saha KN and Mamun MA(2018) Investigate the Cell efficiency Of PKL Cell. Published in the Int: Conference on Electrical, Electronics, Computers, Communication, Mechanical and Computing (EECCMC) 28th & 29th January 2018 Priyadarshini Engineering College, Chettiyappanur, Vaniyambadi - 635751, Vellore District, Tamil Nadu, India.Paper Code: 01-2018-1158
111. K.A. Khan and A K M Obaydullah AKM (2018) Construction and Commercial Use of PKL Cell. Published in the IJARIIE-ISSN(O)-2395-4396, 4(2):3563-3570
112. K.A. Khan, Obaydullah AKM, Wadud MA and Hossain MA (2018)Bi-Product from Bioelectricity. IJARIIE-ISSN(O)-2395-4396, 4(2): 3136-3142
113. Khan KA, Wadud MA, Hossain MA and Obaydullah AKM (2018) Electrical Performance of PKL (Pathor Kuchi Leaf) Power. IJARIIE-ISSN(O)-2395-4396, 4(2):3470-3478
114. Khan KA, Hossain MA, Obaydullah AKM and Wadud MA(2018) PKL Electrochemical Cell and the Peukert's Law. IJARIIE-ISSN(O)-2395-4396, 4(2):4219-4227
115. Khan KA, Ali MH, Mamun MA, Haque MM, Ullah AKMA, Dr. Mohammed Nazrul Islam Khan DMNI,Hassan L, Obaydullah AKM, Wadud MA(2018) Bioelectrical Characteristics of Zn/Cu- PKL Cell and Production of Nanoparticles (NPs) for Practical Utilization. 5th Int: conf. on 'Microelectronics, Circuits and Systems', Micro2018, 19th and 20th May,2018,Venue: Bhubaneswar, Odisha, India, Organizer: Applied Computer Technology, Kolkata, West Bengal, India, Page: 59-66, www.actsoft.org, ISBN: 81-85824-46-1, In Association with: International Association of Science,Technology and Management.
116. Hassan MM, Arif M and Khan KA (2018) Modification of Germination and growth patterns of Basella alba seed by low pressure plasma. Journal of Modern Physics, 5(3), pp:17-18
117. Khan KA, Manir SMM, Islam MS, Jahan S, Hassan L, and Ali MH(2018) Studies on Nonconventional Energy Sources for Electricity Generation.Int: J. Of Advance Research And Innovative Ideas In Education.4(4): 229-244
118. Khan KA, Hasan M, Islam MA, Alim MA, Asma U, Hassan L, and Ali MH (2018) A Study on Conventional Energy Sources for Power Production. Int: J. Of Advance Research And Innovative Ideas In Education. 4 (4) : 229-244
119. Khan KA, Rahman MS, Paul S(2017)I nvestigation on parameters performance of Zn/Cu electrodes of PKL, AVL, Tomato and Lemon juice based electrochemical cells: A comparative study. Publication Year: 2017, Page(s):1-6, Published in: 2017 3rd International Conference on Electrical Information and Communication Technology (EICT), Date of Conference: 7-9 Dec. 2017, Date Added to IEEE Xplore: 01 February 2018,ISBN Information:INSPEC Accession Number: 17542905, DOI: 10.1109/EICT.2017.8275150,Publisher: IEEE, Conference Location: Khulna, Bangladesh 2018
120. K.A. Khan (2018) An Experimental Observation of a PKL Electrochemical Cell from the Power Production View Point. Presented as an Invited speaker and Abstract Published in the Conference on Weather Forecasting & Advances in Physics, Department of Physics, Khulna University of Engineering and Technology (KUET), Khulna, Bangladesh. 2018

121. Guha P, Islam F and Khan KA(2018) Studies on Redox Equilibrium and Electrode Potentials.IJARIIE-ISSN(O)-2395-4396, 4(4):1092-1102, 2018
122. Islam F, Guha P and Khan KA(2018) Studies on pH of the PKL Extract during Electricity Generation for day and night time collected Pathor Kuchi Leaf,IJARIIE-ISSN(O)-2395-4396, 4(4):1103 -1113
123. Hassan SJ & Khan KA (2007) Design, Fabrication and performance study of Bucket type solar candle machine. Int: J. Eng. Trach 4 (3):
124. MAH Khan & K.A. Khan (2005) Selective Black - Nickel coating for use in linear Fresnel Reflecting concentrating collector. Nuclear science and Applications. 14(11) :
125. Khan KA, Rahman ML, Islam MSI, Latif MA, Hossain MA, Saime MA and Ali MH (2018) Renewable Energy Scenario in Bangladesh. J. of IJARII, 4(5) : 270-279, ISSN(O)-2395-4396.
126. Khan KA and Rasel SR (2018) Prospects of Renewable Energy with Respect to Energy Reserve in Bangladesh Published in the journal of IJARII. ISSN(O)-2395-4396. 4(5):280-289
127. Khan KA, Hossain MS, Kamal MM, Rahman MA and Miah I (2018) Pathor Kuchi Leaf : Importance in Power Production. IJARIIE-ISSN(O)-2395-4396 , 4(5):
128. Khan KA, Ali MH, Mamun MA, Ibrahim M, Obaidullah AKM, M. Hossain A and Shahjahan M(2018) PKL Electricity in Mobile Technology at the off-grid region.Published in the proceedings of CCSN-2018, 27-28 October, 2018 at Kolkata, India.
129. Khan KA and Hossain A (2018) Off-grid 1 KW PKL Power Technology: Design, Fabrication, Installation and Operation Published in the proceedings of CCSN-2018, 27-28 October, 2018 at Kolkata, India.
130. Khan KA, Mamun MA, Ibrahim M, Hasan M, Ohiduzzaman M, Obaidullah AKM, Wadud MA and Shajahan M (2018) PKL electrochemical cell for off-grid Areas: Physics, Chemistry and Technology Published in the proceedings of CCSN-2018, 27-28 October, 2018 at Kolkata, India.2018
131. Khan KA, and Rasel SR (2018) Studies on Wave and Tidal Power Extraction Devices. Int: J. Of Advance Research And Innovative Ideas In Education. 4(6):61-70
132. Khan KA, Ahmed SM, Akhter M, Hossen MRAM (2018) Wave and Tidal Power Generation.Int: J. Of Advance Research And Innovative Ideas In Education. 4(6):71-82
133. Khan KA, Rahman MA, Islam MN, Akter M, and Islam MS(2018) Wave Climate Study for Ocean Power Extraction. Int: J. Of Advance Research And Innovative Ideas In Education.4(6):83-93
134. Khan KA, Miah MS, Ali MI, Sharma KS, and Quader A(2018) Studies on Wave and Tidal Power Converters for Power Production. Int: J. Of Advance Research And Innovative Ideas In Education. 4(6):94-105
135. Khan KA, Ali MH, Obaydullah AKM, Wadud MA(2018) Candle Production Using Solar Thermal Systems.1st Int: Conference on 'Energy Systems, Drives and Automations', ESDA2018, Page: 55-66.
136. Khan KA, Rasel SR and Ohiduzzaman M(2018) Homemade PKL Electricity Generation for Use in DC Fan at Remote Areas.1st Int: Conference on 'Energy Systems, Drives and Automations', ESDA2018, Page: 90-99.
137. Khan KA and Yesmin F (2019) PKL Electricity- A Step forward in Clean Energy. Int:J. Of Advance Research and Innovative Ideas In Education. 5 (1): 316-325
138. Khan KA and Yesmin F(2019) Cultivation of Electricity from Living PKL Tree's Leaf. Int: J. Of Advance Research And Innovative Ideas In Education. 5 (1):462-472
139. Khan KA and Yesmin F(2019) Solar Water Pump for Vegetable field under the Climatic Condition in Bangladesh. Int: J. Of Advance Research And Innovative Ideas In Education. 5 (1):631-641
140. Khan KA, Rasel SR and Ohiduzzaman M(2019) Homemade PKL Electricity Generation for Use in DC Fan at Remote Areas.Accepted and is going to be published in Microsystem Technologies, Springer, MITE-D-19-00131, 27 February, 2019.
141. Khan KA, Ali MH, Obaydullah AKM, Wadud MA (2019) Production of Candle Using Solar Thermal Technology. Accepted and is going to be published in Microsystem Technologies, Springer, MITE-D-1900119-, 04 March, 2019.
142. Khan KA , and Rasel SR(2019) Solar Photovoltaic Electricity for Irrigation under Bangladeshi Climate. Int: J. Of Advance Research And Innovative Ideas in ducation. 5 (2): 28-36
143. Khan KA and Rasel SR(2019) The Present Scenario of Nanoparticles in the world. Int: J. Of Advance Research And Innovative Ideas In Education. 5 (2):462-471
144. Khan KA, Yesmin F, Wadud MA and Obaydullah AKM (2019) Performance of PKL Electricity for Use in Television. Int: Conference on Recent Trends in Electronics & Computer Scienc-2019, Venue: NIT Silchar, Assam, India. Conference date: 18th and 19th of March, 2019. Organizer: Department of Electronics and Engineering, NIT Silchar, Assam, India. Page: 69

145. Mamun MA, Ibrahim M and Shahjahan M and Khan KA (2019) Electrochemistry of the PKL Electricity.Int: Conference on Recent Trends in Electronics & Computer Scienc-2019, Venue: NIT Silchar, Assam, India, Conference dates: 18th and 19th of March, 2019. Organizer: Department of Electronics and Engineering, NIT Silchar, Assam, India. Page: 71
146. Khan KA, Hossain MA , Kabir MA, Rahman MA and Lipe P(2019) A Study on Performance of Ideal and Non-ideal Solar Cells under the Climatic Situation of Bangladesh. Int:J. Of Advance Research And Innovative Ideas in Education.5(2): 975-984
147. Khan KA (1999) Copper oxide coatings for use in a linear solar Fresnel reflecting concentrating collector, Publication date 1999/8/1, J. Renewable energy, 17(4) :603-608. Publisher – Pergamon, 1999
148. Ohiduzzaman M, Khan KA, Yesmin F and Salek MA (2019) Studies on Fabrication and Performance of Solar Modules for practical utilization in Bangladeshi Climate. IJARIIE, 5(2): 2626-2637
149. K.A.Khan and Salman Rahman Rasel (2019) A study on electronic and ionic conductor for a PKL electrochemical cell, IJARIIE, 5(2): 3100-3110.
150. M Ohiduzzaman, R Khatun, S Reza, K A Khan, S Akter, M F Uddin, M M Ahasan (2019) Study of Exposure Rates from various Nuclear Medicine Scan at INMAS, Dhaka. IJARIIE, 5(3): 208-218
151. K.A.Khan and Salman Rahman Rasel(2019) Development of a new theory for PKL electricity using Zn/Cu electrodes: per pair per volt, IJARIIE, 5(3):1243-1253
152. K.A. Khan & M. Abu Salek(2019) A Study on Research, Development and Demonstration Of Renewable Energy Technologies, IJARIIE, 5(4):113-125
153. K.A. Khan, Mohammad Nazim Uddin, Md. Nazrul Islam, Nuruzzaman Mondol & Md.Ferdous(2019) A Study on Some Other Likely Renewable Sources for Developing Countries, IJARIIE, 5(4):126-134
154. Hasan,M.& Khan, K.A. (2019) Experimental characterization and identification of cell parametersin a BPLelectrochemicaldevice.SNAppl.Sci.,1:1008.https://doi.org/10.1007/s42452-019-1045-8
155. K.A. Khan & S.M. Zian Reza(2019) The Situation of Renewable Energy Policy and Planning in Developing Countries, IJARIIE, 5(4):557-565
156. K.A. Khan & M. Abu Salek (2019) Solar Photovoltaic (SPV) Conversion: A Brief Study, IJARIIE, 5(5):187-204
157. K.A.Khan, Nusrat Zerin , S.M.Noman Chy.,M.Nurul Islam, Ruchi Bhattacharjee(2019) A study on voltage harvesting from PKL living plant, IJARIIE, 5(5): 407-415
158. K.A. Khan, M.A. Mamun, M. Ibrahim, M. Hasan, M.Ohiduzzaman, A.K.M. Obaydullah, M.A.Wadud, M. Shajahan(2019),PKL electrochemical cell: physics and chemistry,SN Applied Sciences(2019)1:1335,https://doi.org/10.1007/s42452-019-1363-x
159. M. N. F.Rab, K. A. Khan, Salman Rahman Rasel, M Ohiduzzaman, Farhana Yesmin, Lovelu Hassan ,M. Abu Salek , S.M.Zian Reza and M.Hazrat Ali(2019) Voltage cultivation from fresh leaves of air plant, climbing spinach, mint, spinach and Indian pennywort for practical utilization, 8 th international conference on CCSN2019, Vol-1, October, 19th-20th, 2019, Institute of Aeronautical Engineering, Hyderabad, India.
160. M. Hazrat Ali, Unesco Chakma, Debashis Howlader, M.Tawhidul Islam4and K.A.Khan5 (2019) Studies on Performance Para meters of a Practical Transformer for Various Utilizations , 8 th international conference on CCSN2019, Vol-1, October, 19th-20th, 2019, Institute of Aeronautical Engineering, Hyderabad, India.
161. K.A.Khan, Md. Shahariar Rahman, Ali Akter , Md. Shahidul Hoque, Md. Jahangir Khan, Eiskandar Mirja, Md. Nasiruddin Howlader, Mohammed Solaiman(2019) A study on the effect of embedded surface area of the electrodes for voltage collection from living PKL tree, 5(6) , IJARIIE-ISSN(O)-2395-4396
162. K.A.Khan and S.M.Zian Reza(2019) A Study on Maximum Power Harvesting Potential from living PKL tree - Future Energy Resource for the Globe, 5(6), PP:893-903, IJARIIE-ISSN(O)-2395-4396
163. M.Hazrat Ali, Unesco Chakma,Debashis Howlader, M. Tawhidul Islam and K.A.Khan(2019) Studies on Performance Parametersof a Practical Transformer for Various Utilizations, Microsystem Technologies, Springer, Accepted:03 Dec 2019, DOI: 10.1007/s00542-019-04711-w
164. K.A.Khan(2019) Impact of Electrode Surface for Voltage Cultivation from Living PKL Tree, International Journal of Nanotechnology in Medicine & Engineering, 4(5), November 2019
165. K.A.Khan and M. Abu Salek(2019),Future Trends in Vegetative and Fruits Energy- A New Renewable Energy Source for Future Electricity,IJARIIE,5(6), pp:1144-1160
166. K.A.Khan, Alamgir Kabir, Anowar Hossain, Nazmul Alam, Abhijeet Kumar Kundu, Ali Akter (2019) A comparative Study between Lead Acid and PKL Battery, IJARIIE,5(6), pp:1439-1454

167. M. K. A. Khan, A. Rahman, S. Paul, M. S. Rahman, M. T. Ahad and M. Al Mamun (2019), "An Investigation of Cell Efficiency of Pathor Kuchi Leaf (PKL) Cell for Electricity Generation," 2019 International Symposium on Advanced Electrical and Communication Technologies (ISAECT), Rome, Italy, 2019, pp. 1-6.
168. Dr. A K M Obaydullah, Dr. K.A. Khan (2020) Perception of head teachers of primary schools about quality primary science teaching-learning (TL) practice in Bangladesh, SPC Journal of EDucation, Science Publishing Corporation Publisher of International Academic Journals, DOI: 10.14419/je.v3i1.30593,Vol(3),No(1),Pages:18-21.
169. K. A. Khan, Md. Alamgir Kabir , Mustafa Mamun, Md. Anowar Hossain, Samiul Alim(2020),An Observation of Solar Photovoltaic Electricity across the globe, IJARIIE,6(4), pp:1487-504, ISSN(O)-2395-4396
170. K.A.Khan (2020) PKL Electrochemical Cell -A New and Innovative Clean Energy Production System, Hendun Research Access, NTNS, 3(1), pp: 73-78
171. K.A.Khan, M Shaiful Islam, M.N. Islam Khan, Atique Ullah, Shahinul Islam, S. R. Rasel (2020), Zinc Oxide Nanoparticles Production Using *Catharanthus Roseus* Leaf Extract and their Characterization for Practical Utilization, Proceeding of 7th International Conference on Microelectronics, Circuits & Systems,MICRO-2020, 25th and 26th of July, 2020.Venue: Online Conference, In Collaboration with: Delhi Technological University, Delhi, India.
172. K.A.Khan, M Shaiful Islam, Md. Abdul Awal, M.N. Islam Khan, Atique Ullah(2020), Studies on Performances of Copper Oxide Nanoparticles from *Catharanthus Roseus* Leaf Extract, Proceeding of 7th International Conference on Microelectronics, Circuits & Systems,MICRO-2020, 25th and 26th of July, 2020.Venue: Online Conference, In Collaboration with: Delhi Technological University, Delhi, India.
173. Salman Rahman Rasel and K. A. Khan (2020), A Study on Electrochemical Cell based on soil and living PKL tree, Proceeding of 7th International Conference on Microelectronics, Circuits & Systems,MICRO-2020, 25th and 26th of July, 2020.Venue: Online Conference, In Collaboration with: Delhi Technological University, Delhi, India.
174. Lovelu Hassan & K. A. Khan (2020), Applications of PKL electricity for use in DC instruments, Proceeding of 7th International Conference on Microelectronics, Circuits & Systems,MICRO-2020, 25th and 26th of July, 2020.Venue: Online Conference, In Collaboration with: Delhi Technological University, Delhi, India.
175. K.A. Khan and Md. Abdul Awal (2020), A study on connection between chemistry and electricity, IJARIIE-ISSN(O)-2395-4396, Vol-6 Issue-5 2020.

176. K.A.Khan, M.A.Mamun and Sharif Mia(2020), Electrochemical conversion of CO_2 into useful chemicals and PKL electricity, Abstract Published, Proceedings of 9th International Conference on Computing, Communication and Sensor Networks 17th and 18th of October, Organizer: Applied Computer Technology Kolkata, West Bengal, India. www.actsoft.org In Association with: International Association of Science, Technology and Management,Page-19,Venue: Online conference.

177. K.A.Khan and Shahinul Islam(2020), 3R economy of the PKL electrochemical cell, Abstract Published, Proceedings of 9th International Conference on Computing, Communication and Sensor Networks 17th and 18th of October, Organizer: Applied Computer Technology Kolkata, West Bengal, India. www.actsoft.org In Association with: International Association of Science, Technology and Management, Page-26 , Venue: Online conference.

178. K.A. Khan, and Md. Abdul Awal. "A Study on Graphite, Graphene, Graphene Oxide (GO) and Reduced Graphene Oxide (rGO) for Practical Utilization" Internation Journal Of Advance Research And Innovative Ideas In Education Volume 6 Issue 6 2020 Page 422-434
179. K.A. Khan, Syful islam , and Md. Abdul Awal(2020) "A historical review on silver nanoparticles (AgNPs) synthesis for different leaf, vegetative and plant extracts" Internation Journal Of Advance Research And Innovative Ideas In Education Volume 6 Issue 6 2020 Page 705-724

180. K.A. Khan , Shahinul Islam, S. R. Rasel, M. A.Saime, Sazzad Hossain, Md. Atiqur Rahman (2020) Erformance Evaluation Of Pkl (Pathor Kuchi Leaf) Electricity For Use In Television And Radio, Information Management and Computer Science (IMCS) 3(2) (2020) 30-37, *DOI: http://doi.org/10.26480/imcs.02.2020.30.37*

181. K.A. Khan, Samiul Alim, Md Khairul Islam, and Sayed Bony Amin. "Living PKL Plants - An Innovative Idea for PKL back up LED lamp along the Coastal Belts of Bangladesh" ,Internation Journal Of Advance Research And Innovative Ideas In Education Volume 7 Issue 2 2021 Page 112-127

182. K.A. Khan, Shahinul Islam, M. A. Saime, S. R. Rasel, Sazzad Hossain(2021) A NEW AND SUSTAINABLE PKL ELECTRICITY, Topics in Intelligent Computing and Industry Design (ICID) 2(2) (2020) 173-178, DOI: http://doi.org/10.26480/etit.02.2020.173.178
183. Md. Ohiduzzamana, Rajia Sultanab, Rajada Khatunc, Shirin Akterc and K.A.Khand(2021) PORTABLE PKL POWERED LANTERN, Topics in Intelligent Computing and Industry Design (ICID) 2(2) (2020) 179-183, DOI: http://doi.org/10.26480/etit.02.2020.179.183
184. K.A. Khan, Md. Robiul Islam, Md. Anowar Hossain , and Md. Sayed Hossain. "PKL electricity- A new idea on Zn/Cu based electrochemical cell" Internation Journal Of Advance Research And Innovative Ideas In Education Volume 7 Issue 2 2021 Page 641-655
185. K.A. Khan, Md. Anowar Hossain, Md. Robiul Islam , and Md. Abdul Mannan. "A study on Zn/C based Pathor Kuchi Leaf (PKL) electrochemical cell" Internation Journal Of Advance Research And Innovative Ideas In Education Volume 7 Issue 2 2021 Page 975-990
186. K.A Khan,Md. Sayed Hossain,Salman Rahman Rasel, Shahinul Islam,M.Hazrat Ali(2021) A study on Zn/Cu based pandan leaf (Pandanus amaryllifolius)electrochemical cell, 8 th international conference on Micro2021, Microelectronics, Circuits and Systems, May 08th and 09th 2021, Page 15, Venue: Online conference.
187. K.A.Khan, Farhana Islam, Md. Sayed Hossain, Salman Rahman Rasel (2021), Studies on synthesis, characterization and monitoring of Ag NPs for power production using tomato, 8 th international conference on Micro2021, Microelectronics, Circuits and Systems, May 08th and 09th 2021, Page 18, Venue: Online conference.
188. K.A.Khan, Farhana Islam, Md. Sayed Hossain, Salman Rahman Rasel (2021) A Study on Electricity Generation from Red Spinach, 8 th international conference on Micro2021, Microelectronics, Circuits and Systems, May 08th and 09th 2021, Page 22, Venue: Online conference.
189. K.A.Khan, Mohammad Tofazzal Haider,Md. Sayed Hossain, Salman Rahman Rasel (2021) Synthesis, Characterizations of Silver Nanoparticles (Ag NPs) and monitoring for power production using Drum Stick Leaves, 8 th international conference on Micro2021, Microelectronics, Circuits and Systems, May 08th and 09th 2021,Page 31, Venue: Online conference.
190. **K.A.Khan**, Shahinul Islam, Md. Sayed Hossain, Salman Rahman Rasel (2021) Extract of Green Chili: A new source of electricity, 8 th international conference on Micro2021, Microelectronics, Circuits and Systems, May 08th and 09th 2021,Page 35, Venue: Online conference.
191. **K.A. Khan**, Md. Anowar Hossain, Md. Abdul Mannan, and Md. Robiul Islam. "PKL electrochemical cell and battery- The influence of equilibrium constant" Internation Journal Of Advance Research And Innovative Ideas In Education Volume 7 Issue 3 2021 Page 2446-2491
192. **K.A. Khan**, Md. Khairul Islam, Md. Alamgir Kabir, Sayed Bony Amin, Sazzad Hossain, and Md. Shahidul Islam . "A study on variation of product ion and reactant ion during PKL electricity generation" Internation Journal Of Advance Research And Innovative Ideas In Education Volume 7 Issue 4 2021 Page 579-597
193. **K.A. Khan**, Md. Alamgir Kabir, Mustafa Mamun, Sazzad Hossain, and Md. Shahidul Islam. "PKL electricity - The Role of Physics" Internation Journal Of Advance Research And Innovative Ideas In Education Volume 7 Issue 4 2021 Page 1583-1606
194. **K.A. Khan**, Md. Khairul Islam, Sayed Bony Amin, and Khandaker Kabir Hossain. "Leaf and vegetative extract electrochemical cells - In comparative research for capacity study" Internation Journal Of Advance Research And Innovative Ideas In Education Volume 7 Issue 4 2021 Page 2336-2353
195. **K.A. Khan**, Md. Khairul Islam, Sayed Bony Amin, and Md. Abdur Rahim. "Prospects of PKL Electricity" Internation Journal Of Advance Research And Innovative Ideas In Education Volume 7 Issue 5 2021 Page 563-582
196. **K.A. Khan**, Md. Alamgir Kabir, Mustafa Mamun, Mst. Sakera Khatun, and Muhammad Saiful Islam Akhand. "Effect of pH of the PKL extract during electricity production" Internation Journal Of Advance Research And Innovative Ideas In Education Volume 7 Issue 5 2021 Page 583-600
197. **K.A. Khan**, Khairul Islam, Sayed Bony Amin, and Khandaker Kabir Hossain. "A study on current density for PKL electrochemical cell" Internation Journal Of Advance Research And Innovative Ideas In Education" Volume 7 Issue 6 2021 Page 9-24
198. Motiur Rahman , M Shamsuzzaman, Manoshi Sarker , Abdul Jobber , Mohsin Mia , Asish Kumar Bairagi , Musfika Ahmed , Shohel Reza , Sadiq R Malik , MMH Bhuiyan , ASM Habibullah Khan and **MKA Khan** (2021), Dosimetric

characterization of medical linear accelerator Photon and Electron beams for the treatment accuracy of cancer patients, World Journal of Advanced Engineering Technology and Sciences, 2021, 03(01),041–059,Publication history: Received on 04 May 2021; revised on 11 August 2021; accepted on 13 August 2021,Article DOI: https://doi.org/10.30574/wjaets.2021.3.1.0046

199. **K.A. Khan**, Akhtar-Uz-Zaman Shabuj, Md. Khairul Islam, Sayed Bony Amin, & Md. Abdur Rahim. (2021). AgNPs for Power Production. Internation Journal Of Advance Research And Innovative Ideas In Education, 7(6), 323-338.

200.Khan KA, Bhuyan MS., Mamun M A., Ibrahim M., Hasan L., Wadud M.A.(2018), Organic Electricity from Zn/Cu-PKL Electrochemical Cell, In: Contemporary Advances in Innovative and Applicable Information Technology, Advances in Intelligent Systems and Computing, J. K. Mandal et al. (eds.), © Springer Nature Singapore Pvt. Ltd., 2018, Vol. 812, Chapter 9, p 75-90.

201. Kamrul Alam Khan, Salman Rahman Rasel, S.M. Zian Reza and Farhana Yesmin (March 25th 2020). Energy Efficiency and Sustainability in Outdoor Lighting - A Bet for the Future, Energy Efficiency and Sustainable Lighting - a Bet for the Future, Manuel Jesús Hermoso-Orzáez and Alfonso Gago-Calderón, IntechOpen, DOI: 10.5772/intechopen.89413. Available from:

202. K.A.Khan, Farhana Yesmin, Md. Abdul Wadud and A K M Obaydullah (2019), "Performance of PKL Electricity for Use in Television", accepted as a book chapter NAROSA publisher, September 2019.

203. M. N. F.Rab, K. A. Khan, Salman Rahman Rasel, M.Hazrat Ali, Lovelu Hassan , M. Abu Salek , S.M.Zian Reza and M Ohiduzzaman(2020) "Voltage Cultivation from Fresh Leaves of Air Plant, Climbing Spinach, Mint, Spinach and Indian Pennywort for Practical Utilization", Energy Systems, Drives andAutomations, Springer Singapore, Lecture Notes in Electrical Engineering, eBook ISBN: 978-981-15-5089-8, DOI: 10.1007/978-981-15-5089-8, Hardcover ISBN: 978-981-15-5088-1, Series ISSN: 1876-1100, Volume: 664,Page: 150-160.

204. K. A. Khan, Salman Rahman Rasel, S.M.Zian Reza**,** M. A. Saime, Nazmul Alam, Abu Salek , MehediHasan (2020) "Solar Medical Sterilizer using Pressure Cooker for Rural off-grid Areas", Energy Systems, Drives andAutomations, Springer Singapore, Lecture Notes in Electrical Engineering, eBook ISBN: 978-981-15-5089-8, DOI: 10.1007/978-981-15-5089-8, Hardcover ISBN: 978-981-15-5088-1, Series ISSN: 1876-1100, Volume: 664,Page: 258-269.

205. K. A. Khan, M. A. Saime, M.Hazrat Ali, S. M. Zian Reza, Nazmul Alam**,** Md. Afzol Hossain, M. N.F.Rab and Shahinul Islam (2020) "A study on PKL electrochemical cell for three different conditions ", Energy Systems, Drives andAutomations, Proceedings of ESDA 2019 , Springer Singapore, Lecture Notes in Electrical Engineering, eBook ISBN: 978-981-15-5089-8, DOI: 10.1007/978-981-15-5089-8, Hardcover ISBN: 978-981-15-5088-1, Series ISSN: 1876-1100, Volume: 664, Page: 374-386.

206. Khan K. et al. (2020) A Study on Development of PKL Power. In: Mandal J.K., Mukherjee I., Bakshi S., Chatterji S., Sa P.K. (eds) Computational Intelligence and Machine Learning. Advances in Intelligent Systems and Computing, vol 1276. Pp151-171,Springer, Singapore. http://doi-org-443.webvpn.fjmu.edu.cn/10.1007/978-981-15-8610-1_17

207. Pervin R., Khan K.A., Khan N.I., Atique Ullah A.K.M., Zian Reza S.M. (2021) Green Synthesis of Magnetite (Fe3O4) Nanoparticles Using Azadirachta indica Leaf Extract and Their Characterization. In: Mukherjee M., Mandal J., Bhattacharyya S., Huck C., Biswas S. (eds) Advances in Medical Physics and Healthcare Engineering. Lecture Notes in Bioengineering. Springer, Singapore. https://doi.org/10.1007/978-981-33-6915-3_9, First Online17 June 2021, DOIhttps://doi.org/10.1007/978-981-33-6915-3_9, Publisher NameSpringer, Singapore. Page: 81-90

208. Khan K.A., Sultana R., Islam S., Zian Reza S.M. (2021) A Study on Light Traps for Attracting and Killing the Insects Using PKL Electricity. In: Mukherjee M., Mandal J., Bhattacharyya S., Huck C., Biswas S. (eds) Advances in Medical Physics and Healthcare Engineering. Lecture Notes in Bioengineering. Springer, Singapore. https://doi.org/10.1007/978-981-33-6915-3_14, First Online17 June 2021, DOIhttps://doi.org/10.1007/978-981-33-6915-3_14,Publisher NameSpringer, Singapore.pp:135-143

209. Hossain M.A. et al. (2021) PKL Electricity-An Observations. In: Mukherjee M., Mandal J., Bhattacharyya S., Huck C., Biswas S. (eds) Advances in Medical Physics and Healthcare Engineering. Lecture Notes in Bioengineering. Springer, Singapore. https://doi.org/10.1007/978-981-33-6915-3_53, First Online17 June 2021, DOIhttps://doi.org/10.1007/978-981-33-6915-3_53, Publisher NameSpringer, Singapore.pp: 555-566

210. Khan K.A., Rahman M.S., Rahman M.N., Khan S.A., Juel M.I., Nirjhar M.I. (2021) A Study on Electrochemical Characterizations of Bryophyllum pinnatum Leaf Electricity. In: Mukherjee M., Mandal J., Bhattacharyya S., Huck C., Biswas S. (eds) Advances in Medical Physics and Healthcare Engineering. Lecture Notes in Bioengineering. Springer, Singapore. https://doi.org/10.1007/978-981-33-6915-3_54 , First Online17 June 2021, DOIhttps://doi.org/10.1007/978-981-33-6915-3_54, Publisher NameSpringer, Singapore. pp 567-581

211. Hassan L., Khan K.A. (2021) Applications of PKL Electricity for Use in DC Instruments. In: Biswas A., Saxena R., De D. (eds) Microelectronics, Circuits and Systems. Lecture Notes in Electrical Engineering, vol 755. Springer, Singapore. https://doi.org/10.1007/978-981-16-1570-2_18, pp:191-202

212.Khan K.A., Shaiful Islam M., Awal A., Khan M.N.I., Ullah A.K.M.A. (2021) **Studies on Performances of Copper Oxide Nanoparticles from Catharanthus Roseus** Leaf Extract. In: Biswas A., Saxena R., De D. (eds) Microelectronics, Circuits and Systems. Lecture Notes in Electrical Engineering, vol 755. Springer, Singapore. https://doi.org/10.1007/978-981-16-1570-2_17,pp:179-190

213. Khan KA (2008) Patent as an Inventor, Electricity Generation form Pathor Kuchi Leaf (PKL), Publication date 2008/12/31, Patent number BD 1004907

214. Khan DMKA (1997) Patent as an Inventor, Production of Soap by Solar System. Patent Serial No. 10029941

215. Khan DMKA (1999) Patent as an Inventor, Improvement in or Relating to Production

of Candles by Solar System. Patent Serial No. 1003287

216. Khan DMKA (2001) Patent as an Inventor, Medical Sterilizer by Solar System. Patent Serial No. 1003646