"Study of electrical properties of metal/ metaloxides doped polymer blend composites"

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Abstract:

This work presents enhancement of electrical properties by selecting such polymericblends composite materials doped/ filled with metal / metal oxides synthesized using various methods *viz.*mixing methods, magnetic stirrer, situ chemical oxidation polymerization (SCOP) method, pylol method, which are helpful for energy storage in electronic devices and better efficiencies and would be always welcome in society for advance technologies. These synthesized materials are usually characterized using FT-IR, XRD, SEM/TEM and AFM for their structural analysis. FESEM with EDX provides the morphological analysis and elemental composition of the samples. Authors have been interested in studying the electrical thermaland optical behavior of such composites. The electrical conductivity of these composite is normally studied using two probe technique or impedance analyzer . Thedielectricconstant, AC & DC electrical conductivity of the synthesized composite is evaluated from the obtained data.The need for energy storage systems with high energy density has led to the development of polymer composite systems that combine the processability and breakdown field strength of the polymer with the high dielectric constant of ceramic fillers. Ideally, the fillers help to increase the effective dielectric constant of the composite system without compromising the high inherent breakdown strength of polymers. Moreover, increasing the effective dielectric constant must be achieved without an unacceptably large increase in dielectric loss (i.e., energy dissipation). In reality, the objectives of high dielectric constant, high breakdown field strength, and low dielectric loss are not likely to all be achieved; the best solution will be a compromise. Consequently, much research is being carried out to develop improved polymer composite materials through a better understanding of the physical phenomena governing composite dielectric permittivity and breakdown field strength.It is interesting to note that certain composites show paramagnetic behavior. Aninteresting property of these paramagnetic polymeric metal oxide composites is that when subjected to an e-m field, they change position, modify their color and reflective properties. These materials are quite interesting to be used for coating paints(electrochromic paints), electronic devices and highdurability cells etc.

Keywords: Polymeric blend composites, metaloxides filler, FT-IR, XRD, AFM, SCOP, electrical properties, paramagnetic metal oxide, electrochromic paints.

Introduction:

From last two decades material scientists have been experimenting with polymeric materials by compounding them with co-polymers, their blends or by adding variety of fillers to yield desired properties for specific applications [P-1, 5]. Recently, a considerable interest has grown in the field of developing filler doped polymer blend composites; as the introduction of the organic/inorganic filler even in small quantities to the polymer matrix significantly enhances their thermo-physical properties leading to development of materials of desired properties and fascinating applications [P-9, 10]. The changes in physical properties of the composite material depend on the chemical nature of the filler metal and on the interaction mechanism between the filler and the polymer matrix. In this proposed research we look forward to development of metal oxide doped polymeric blend material having high dielectric constant, high breakdown field strength and low dielectric loss.

In this work, we propose a simple, inexpensive, and environmentally friendly solution blending method for the fabrication of PVDF/PMMAblends with different concentrations of doped metal oxide nanoparticles. We intend to study the mechanism of charge storage and conduction and the structure property correlation in these by examining the samples using various characterization tools like Scanning electron microscopy (SEM); X-raydiffraction(XRD), Fourier transform infrared (FTIR) spectroscopy and Impedance Analyzer. This study shall alsoconcentrateontheinfluenceofmetaloxidenanoparticlesonelectricalpropertiesofthese composites.

Overview of Research:

Last few decades have seen overwhelming advances in the field of design, development and manufacturing of materials whether they may be small molecular size inorganic materials or large long chain macromolecular materials. The development of certain metallic materials suffer from various limitations of having high manufacturing cost, difficulties of making them in desired shapes and sizes and their being difficult or rather impossible for further processing [P-28, 36]. Contrary to it, the synthesis of macromolecular materials is easier, cost effective and amenable for mass production. Further these materials are flexible, not bulky and heavy and can be processed in variety of sizes and shapes offering a large number of applications [P-2, 9, 10, 11, 36]. But these materials also suffer from certain limitations of being non conducting, having low thermal conductivity, swell up in water, degrade on weathering etc.[P-22,23,30]. So the need of the hour is to fabricate and design such materials that mitigate such limitations. One of the several ways to trounce such limitations of small dimensionally-structured materials or the large molecule consisting polymers is by embedding a very small amount of these small dimensional materials as filler in the polymer. It is expected that the inclusion of small size particles into the polymer makes properties of both the added particles and the polymer to combine or even enhance, resulting in desired advanced new functions and applications. From the beginning of twenty first century an intensive interest has risen in developing inorganic/organic doped polymer composites as alternative materials to existing materials for their improved mechanical, electrical, thermal and optical properties. Literature review suggests that it is possible to fine tune these properties by controlling the concentration and size of particles [P-24, 43].

Identifying the Existing Research Gap :

Dielectric materials can be used to store electrical energy in the form of charge separation when the electron distributions around constituent atoms or molecules are polarized by an external electric field. The complex permittivity of a material can be expressed as:

$$\varepsilon = \varepsilon' - j\varepsilon''$$

ε'andε''being respectively the real and imaginary part of dielectric constant of the material.

The magnitude ofε'(or the dielectric constantε_r) indicates the ability of the material to store energy from the applied electric field. A parallel plate capacitor with area A and thickness *t* has a capacitance given by: $C = \varepsilon' A / t = \varepsilon_0 \varepsilon_r A / t$. The imaginary part of the permittivity, ε'' is called the dielectric loss. As the polarization of a material under an applied electric field varies, some of the field energy is dissipated due to charge migration (i.e., conduction) or conversion into thermal energy (e.g., molecular vibration). *For energy storage device like a capacitor, we obviously wish to minimize the dielectric loss.*

Ceramic capacitors based on highly polarizable inorganic materials have traditionally been used to meet the need for pulse power applications. The energy stored by a capacitor is given by:

$$W = 1/2C(V_{bd})^2$$

Where V_{bd} is breakdown voltage and $E_{bd} \equiv V_{bd}/d$ is the breakdown field strength. Despite having high dielectric constants ceramic capacitors have low inherent breakdown field strength, which results in low energy density. Moreover, it is difficult to manufacture ceramic capacitors with the desired high capacity for energy storage.

Polymers, on the other hand, are easily processed into large area films, and several polymers have relatively high breakdown field strengths. Unfortunately, they also typically have low dielectric constants and thus low energy densities.

The need for energy storage systems with high energy density has led to the development of polymer composite systems that combine the process ability and breakdown field strength of the polymer with the high dielectric constant of ceramic fillers. Ideally, the fillers help to increase the effective dielectric constant of the composite system without compromising the high inherent breakdown strength of polymers. Moreover, increasing the effective dielectric constant must be achieved without an unacceptably large increase in dielectric loss (i.e., energy dissipation). In reality, the objectives of high dielectric constant, high breakdown field strength, and low dielectric loss are not likely to all be achieved; the best solution will be a compromise. Consequently, much research is being carried out to develop improved polymer composite materials through a better understanding of the physical phenomena governing composite dielectric permittivity and breakdown field strength. As both of these issues are likely to involve the polymer-filler interface, research seeking a better understanding the chemistry and structure of the filler-polymer interface is a priority.

Most of the current studies on dielectric polymer composites focus on the enhancement of the dielectric permittivity using ferroelectric metal oxides $Pb(Zr,Ti)O_3$, $Pb(Mg_{0.33}Nb_{0.77})O_3$-$PbTiO_3$ (PMNT), and $BaTiO_3$ (BT). From the point of view of increasing the composite's effective dielectric constant, the availability of inorganic fillers with dielectric constants on the order of hundreds and even thousands makes it very appealing to introduce them into polymers, which generally possess dielectric constants less than 10. However, the resulting composites' effective dielectric constants generally fall short of expectations. Specifically, since the filler has a much greater permittivity than that of the polymer matrix, most of the increase in the effective dielectric constant comes through an increase in the average field in the polymer matrix, with very little of the energy being stored in the high permittivity phase. Also, the large contrast in permittivity between two phases can give rise to highly inhomogeneous electric fields. Lastly, incompatibility between the organophilic polymer matrix and the hydrophilic metal oxide filler impedes the formation of a homogenous composite. Thus, a major research direction in this field remains focused on selection of inorganic filler surface to compatibilize the inorganic filler with the polymer matrix. Highly inhomogeneous fields and structural inhomogeneity generally lead to a significant reduction in the effective breakdown field strength of the composite, limiting the increase in the energy storage capacity and energy density. Clearly there are several persistent issues that need to be overcome to increase the energy density and capacity of dielectric polymer composite materials.

Solution to the problem statement:

Blending of different polymers and addition of inorganic particles within them offers novel materials with tailored properties, which are different from that of constituent polymers. Hence, this technique has been extensively used in plastics, rubbers, composites, and adhesives [P-2,24]. The properties of the blend depend on the degree of compatibility or miscibility of the polymers at molecular mixing; blends being classified as compatible or miscible and incompatible or immiscible blends [P-2,5,24]. The polymer miscibility occurs due to some specific interactions such as dipole–dipole forces, hydrogen bonding, and charge transfer complex between the polymer segments. It is estimated that at least 70% of the compounds in use today are based on polymer blends. The addition of inorganic particles to blends results in the improvement of various technological properties and reduction in cost.

Poly(vinylidene fluoride) (PVDF)is a semi crystalline water-soluble, nontoxic, biodegradable synthetic polymer having good charge storage capacity and dielectric strength has excellent thermal stability, resistance to radiation often used as insulator. It is UV resistant and has high dielectric constant and has wide range operating temperatures. It can be injected, molded or welded and is commonly used in the chemical, semiconductor, medical and defense industries, as well as in lithium-ion batteries. It has a carbon chain backbone with a two hydrogen and two fluorine group attached to two carbons, and these hydrogen and fluorine atoms prove to be a good source of hydrogen and vanderwaalbonding, which favors the formation of interpenetrating network structure in the polymer composite.The reasons for selecting it as our host polymer is that when poled, PVDF is a ferroelectric polymer, exhibiting efficient piezoelectric and pyroelectric properties. These characteristics make it useful in sensor and battery applications.

Poly methyl methacrylate (PMMA) commonly known as acrylic glass and bearing IUPAC nomenclature as poly(methyl 2-methyl propenoate) is a hard and amorphous synthetic thermoplastic. Due to its high transparency, light weight and impact resistance it is generally used as an alternative to glass. Of the three different stereo regular arrangements of it, the isotactic (iso-PMMA) is semicrystalline; syndiotactic (synd-PMMA) is crystalline and atactic (a-PMMA) is purely amorphous one. Preliminary studies suggested that polymers with high degree of crystallinity have low ionic conductivity, so to overcome this issue atactic PMMA having amorphous phase with flexible backbone chains having high ionic conductivity is preferred.It was an instant choice also due to its other thermo-physical moderate properties, easy of handling and processing and low cost.Another big deciding factor in its favour was that it is compatible with most of the polymers, exhibits higher surface resistance and high ability to solvate inorganic/organic salts to form compleation between polymer and salt [P-24,33]. Also though it is almost insulating in nature with high elastic strength; its conducting property can be enhanced by adding either metal oxide or supporting agent.

When these two polymers are mixed, we expect the interaction of PVDF and PMMA to take place through hydrogen bonding between the hydrogen atom of PVDF and the carbonyl group of PMMA. Therefore, we expect blending of such polymers with polar inorganic salt would lead to the uniform dispersion of fillers in the polymers resulting in improved electric properties.

A careful literature survey also reveals that in recent years, polymer blend nanocomposites have attracted extensive interest as the properties of these materials could be controlled through proper functionality of polymers or segment size of each component, which result in good mechanical, electrical, electronic, and optical properties [P-1, 6, 7, 31]. These properties depend not only on the properties of the individual polymer but also on the phase morphology of the polymer matrix and the interfacial interaction of nanoparticles with the polymer component. Among the transition metals, iron oxide, stannous oxide, copper oxide, sulfide and zinc oxide filler have special physicomechanical properties arising from their high surface area and quantum size effects. Thermal stability, flameretardancy, and conductivity of polymer blend nanocomposites are much enhanced by the addition of a small quantity of metal oxide nanoparticles, which is attributed to their crystalline nature resulting from the uniform dispersion of nanoparticles[P-35,38,41]. Doping of conductive metal with transition metal oxide nanoparticles has considerable interest due to their application in electrical, electronics, optics, and photonics.

Synthesis of ion conducting polymer composites materials:

Lithium ion conductivity and characterization of PMMA and PVC based polymer electrolytes incorporating ionic liquid/salts and nano fillers(Al_2O_3, TiO_2& SiO_2) which are classified as SPE(Solid Polymer Electrolyte), GPE(Gel Polymer Electrolyte) and CPE(Composite Polymer Electrolyte) ,their synthesis and fabrication required several conditions and equipments which are not easily available near our surroundings, like raw materials followed by the formulation of mesoporous silica reinforcements, polymer electrolytes, composite polymer electrolytes as well as the fabrication of structural supercapacitors by **resin infusion under flexible tooling (RIFT) process**.

In the recent past, research efforts have targeted the development of other multifunctional storage systems including structural batteries, structural capacitors and structural fuel cells. The paradigm of a novel multifunctional structural supercapacitor was adopted in this work in order to develop a low weight multifunctional composite possessing specified electrical and mechanical properties. Glass fibres, along with filter papers and polymer membranes, were used as separators. Different polymer matrices were used as polymer electrolytes, including polyacrylonitrile (PAN), diglycidylether of bisphenol-A (DGEBA) and polyethylene glycol diglycidylether (PEGDGE). Mesoporous silica particles were used as reinforcements embedded into the polymer matrix. Table given below shows the structural supercapacitor to the multifunctionality of the final composite and its requirements.

	Mechanical	**Electrical conductivity**	**Ionic conductivity**	**Requirements**
Polymer matrix	Yes	No	Yes	Light weight, decent mechanical properties and ionic conductivity
Carbon fiber mats	Yes	Yes	No	High surface area, Excellent mechanical properties
Glassfiber mats	Yes	No	No	Good mechanical properties, porosity, Electronic insulator and sufficiently dense
Mesoporous silica	Yes	No	Yes	High surface area, narrow particle size distribution, high porosity, mechanical properties

Table: Contributions of the individual components in the proposed multifunctional composites.

Objective of the Research Work:

During this research work we intend to develop such solid polymer electrolyte composite materials by doping metal oxide viz. ZnO, SnO_2 and Fe_2O_3 or metals like Cr or Mnin different concentration into the blends of poly(methyl methacrylate) (PMMA) and polyvinylidene fluoride (PVDF) polymers to understand the mechanisms related to charge storage as well transportations of conducting ions in these materials. To enrich the depth of understanding about the structure property correlationship; we need to also explore the morphological and structural properties of these composite materials. This information can be obtained by characterizing our synthesized composites using Scanning electron microscopy (SEM); X–ray diffraction analysis (XRD) and Fourier Transform infrared analyzer (FTIR), AFM etc. The electrical characterization shall be carried out using Impedance analyser and Hall measurements.

Proposed Methodology/ Laboratory Work:

To achieve the above objective we need to undertake the following steps:-

- *Synthesis of pristine PVDF and pristine PMMA films of thickness around 150 μm.* These samples for pure PVDF and pure PMMA shall be referred as SP1 and SP2 respectively.
- *Synthesis of PVDF/PMMA blends in different ratios*: The blends of PVDF/PMMA in the following ratios 10/90 wt %, 30/70 wt %, 50/50 wt% , 70/30 wt % and 90/10 wt % are proposed to be prepared by melt mixing method. These samples shall be christened as SB1, SB2, SB3, SB4 and SB5 accordingly. The structural and electrical characterization of these samples shall be carried out using SEM, XRD, FTIR and Impedance spectroscopy.

- *Synthesis of various metal oxides doped in various concentration in PVDF/PMMA blend films:* To understand the effect on electrical properties due to insertion of metal oxide in the polymer blend we propose to disperse the following metal oxides viz..ZnO, SnO_2 & Fe_2O_3 separately in different ratios 1%, 3%, 5% and 8% in the films SP1, SP2 and SB1 to SB5 during the polymerization process itself as per solution cast method. The films so prepared on dispersing ZnO in the pristine shall be referred as SPZ11 to SPZ14 and SPZ21 to SP24 for pristine polymers and for blend compositions shall be referred as SBZ11 to SBZ14, SBZ21 to SBZ24, SBZ31 to SBZ34, SBZ41 to SBZ44 and SBZ51 to SBZ54. Similarly the films prepared by dispersing SnO_2 shall be referred as SPS11 to SPS14 and SPS21 to SPS24 for pristine polymers and SBS11--SBS14, SBS21—SBS24, SBS31—SBS34, SBS41—SBS44 and SBS51—SBS54 respectively for blend compositions. Adopting the same trend the films obtained on dispersing Fe_2O_3 shall be referred as SPF11 to SPF14 and SPF21 to SPF24 for pristine polymers and SBF11--SBF14, SBF21—SBF24, SBF31—SBF34, SBF41—SBF44 and SBF51—SBF54 respectively for blend compositions.
- Investigation of Structural and Electrical properties of the synthesized composites.

The structural analysis of our samples shall be carried out by employing the following techniques:-

X-Ray Diffraction (XRD) patterns for analyzing the crystallinity and evaluating the crystallite size of our samples.

FTIR (Fourier Transform Infrared) Spectroscopy shall be used to identify how well the interactions have taken place between the host polymeric blend and the metal oxide filler

*SEM (Scanning Electron Microscope)*imagesshall be obtained to get information about the surface topography and composition of the sample and that how well these metal oxides hve dispersed into the material.

*LCR Meter and Impedance Analyser:*The study of variation in dielectric properties with frequency provides an understanding of the capacitive or conductive nature of the material. The values of impedance parameters *viz.* resistance, capacitance, inductance, dissipation factor (tan δ), phase angles and impedance shall be measured using Impedance analyzer setup or LCR meter in the frequency range (100 Hz – 100 MHz) at room temperature for all the prepared samples. The breakdown strength of the composite films would also be measured using high voltage amplifier under a ramp voltage rate.

Literature Review:

Electrical properties of filler doped polymers:

*M. T. Ramesanet. al*have explained the synthesis of metal complexes of poly (methyl methacrylate) (PMMA)/ stannous chloride by an in situ polymerization of methyl methacrylate with different molar concentrations of $SnCl_2$. The incorporation of $SnCl_2$ in main chain of PMMA enhances excellent thermal resistance and the thermal stability of polymer complexes increased with increase in concentration of $SnCl_2$.

The electrical properties of all polymer metal complexes were higher than pure PMMA and the conductivity increased with increase in molar concentration of $SnCl_2$. They state that the increase in conductivity with the increase in loading of metal was due to the increase in volume of interfaces where the particle to particle distance is too small.

The dielectric and conductivity behaviors of Polypyrrole and polypyrrole / copper zinc iron oxide ($CuZnFe_2O_4$) nanocomposites synthesized by in-situ polymerization using different weight percentages of nanofiller have been studied by *V.S. Shanthalaet.al* using impedance spectroscopy at different temperatures and frequencies (100 Hz–5 MHz). Dielectric relaxation was observed at low frequency range, calculation for relaxation time has been carried out from the dielectric loss peaks. The highest conductivity was observed at 373K for all nanocomposites. The significant increase in dielectric constant makes them a potential candidate for dielectrics in capacitors used for decoupling, timing, filtering, and many other functions.

*Shilpa Vijay et. al*have reported a study on the frequency and composition dependent dielectric properties and a.c. conductivity of Poly Methyl Methacrylate/Multiwall Carbon Nanotubes (MWCNT_PMMA) nanocomposites. The authors suggest the use of CNT/polymer nanocomposite membranes as a good charge separating media as according to their study the dielectric constant shows a dramatic enhancement in permittivity on increases of MWNT concentration and a decrease in dielectric constant with increasing frequency in these nanocomposites. The a.c. conductivity of PMMA/MWNT nanocomopsites was also reported to increase with frequency of applied electrical field and with increased concentration of MWNT. They suggested that by dispersing MWNTs in polymer matrix one can improve charge transport properties of the material.

According to *Aras and Baysal*, *Komala et. al.*rice husk can also be considered as important reinforcing filler for polymer composites. Theysuggests that electrical properties of reinforced plastics are affected by the volume of reinforcement fibers introduced in the combination.

Paul and Thomas have studied the electrical properties of sisal fiber-low density polyethylene (LDPE) and coir fiber-LDPE composites. They showed that the dielectric constant increases with increase of fiber loading and decreases with increase of frequency in the case of all composites. They have studied the dielectric constant of sisal-LDPE composites as a function of fiber length too.*Chand and Jain* have studied the effect of sisal fiber on electrical properties of epoxy composites in their paper.

Ashish Gupta; has studied experimental study on ion conducting polymer electrolytes.

LiewChiamWen ; has studied investigation on Li ion conducting and characterization of PMMA/PVC based polymer electrolyte incorporating ionic liquid and nano filler.

S. No	Title	Publication	Year	Author	Work Done
1	Influence of doping concentration on Dielectric , Optical and Morphological properties of PMMA thin films	Polymer Composites	2018	Lyly Nyl Ismail, Habibah Zulkefle, Sukreen Hana Herman and Mohd. Ruso Mahmood	Physical and optical properties of PMMA blends
2	Copolymerization and blending bands PEO/PMMA/P(VDF-HFP) gel polyelectrolyte for rechargeable lithium metal batteries	Journal of membrane science 547,1-10	2018	Juan Shi, Yifu Yang, Huixia shao	polyelectrolyte for rechargeable lithium metal batteries
3	Multifunctional Bicontinous composite with Ultralow Percolation Thresholds	ACS Applied Materials & Interfaces , 10 (24), 20806-20815	2018	Jiabin XiYingjun LiuYing WuJiahan HuWeiwei GaoErzhen ZhouHonghui ChenZichen ChenYongsheng ChenChao Gao	**Discussing Ultralow Percolation Thresholds**
4	Electrical control of charged carriers and excitons in atomically thin materials	Published 15 january 2018	2018	ZhouHonghui ChenZichen	TMDs offers a new route towards realizing novel 2D quantum electronic devices
5	Evidence for an Electronic State at the Interface between the SnO$_2$ Core and the TiO$_2$ Shell in Mesophorous SnO$_2$/TiO$_2$	American Chemical Society	2018	G J Meyer	Single potential-independent absorption spectrum was observed and attributed to e^- present within an interfacial region bet^n the core and the shell
6	Electrical. Optical and mechanical properties	Phase Transitions ,	2018	Ertan Arda, Ömer Bahadır Mergen,	Improved response and

	of PS/GNP composite films	91 (8), 887-900		Gülşen Akın Evingür	high mechanical strength material is observed
7	Mechanical and electrical conductivity properties of graphene based thermoplastic starch / poly(lactic acid) hybrids	Polymer Composites ,18	2018	Willian H. Ferreira, Karim Dahmouche, Cristina T. Andrade	Tuning the Mec. And electrical conductivity
8	Thermal , electrical and characterization effects of graphene on the properties of low density polyethylene composites	International Journal of Plastics Technology 2018 22 (2), 234-246.	2018	Maziyar Sabet, Hassan Soleimani,	Characterization effects of graphene
9	Preparation and characterization of PMMA PVDF based polymer composite electrolyte material for dye sensitized solar cell (Al_2O_3)	Current Applied Phy, Vol.18 Issue 6, June 2018, Pg 619- 625	2018	J R Nair	Blend characterstics
10	Polymer based nanocomposite for energy and environmental applications	Woodhead Publishing Series and Engineering , 2018, Pg 283-313	2018	S. Farrari ; J R Nair; Y Zhan; C Wan	Polymer nanocomposites for lithium battery application
11	Electrical and Mechanical Properties of ZnO/(UPE-PMMA) Blend Nanocomposites	10.5923/j.cmaterials.20170702.02	2018	Fadhil K. Farhan, Zainab AL- Ramadhan, Widad A. Abd-AL Hussein	Enhance properties
12	Improved Dielectric Constant of Modified Polymer Blend by Nickel Oxide Nanoparticles,	materialstoday, march 2018	2018	Moumita Khutia, Girish M. Joshi, Mayank Pandey	Dielectric properties
13	Structural and Electrical Properties of Graphene Oxide-Doped PVA/PVP Blend Nanocomposite Polymer Films	Advances in Materials Science and Engineering, Volume 2018, Article ID 4372365, 11	2018	S. K. Shahenoor Basha, K. Vijay Kumar, G. Sunita Sundari, and M. C. Rao	Enhancement of structural properties when graphene oxide is doped in

		pages,			PVA/PVP blend
14	Dielectric and Electrical Properties of different inorganic nanoparticles dispersed phase separated polymeric nano composite bilayer films	Indian Journal of Chemical Technology, VOL.24,pp.311-318, 2017.	2017	Shobhna Choudhary	Dielectric properties by the use of nano composite bilayer films in inorganic nanoparticles
15	Electrical and Mechanical Properties of Wood Plastic Composites	scau. edu. cn ; Tel./Fax: +86-451-8219-1993, Received: 13 October 2017; Accepted: 11 November 2017; Published: 16 November 2017	2017	Xingli Zhang ID , Xiaolong Hao , Jianxiu Hao and Qingwen Wang	Effect of the Addition of Carbon Nanomaterials
16	Methods fabrication of graphene polyimide nanocomposites with superior electrical conductivity	ACS Applied Materials & Interfaces 2017 9 (49), 43230-43238.	2017	Mitra Yoonessi, James R. Gaier, Muhammad Sahimi, Tyrone L. Daulton, Richard B. Kaner, and Michael A. Meador	Study of electrical conductivity of graphene polyimide
17	PDMS/SCF composite sheets with bolting cloth prepared by a spatial confining forced network assembly method	RSC Advances 2017 7 (24), 14761-14768	2017	Xiaolong Gao, Yao Huang, Ying Liu, Semen Kormakov, Xiuting Zheng, Dan Wu, Daming Wu	Improved conductivity
17	PDMS/SCF composite sheets with bolting cloth prepared by a spatial confining forced network assembly method	RSC Advances 2017 7 (24), 14761-14768	2017	Xiaolong Gao, Yao Huang, Ying Liu, Semen Kormakov, Xiuting Zheng, Dan Wu, Daming Wu	Improved conductivity
18	Dielectric and electrical properties of different inorganic nano particles dispersed phase separated polymeric nano	Indian Journal of Chemical Technology	2017	Shobhna Choudhary	Study of dielectric and electrical properties

	composite (PNC) bilayer film like PVA/PMMA with 5wt% of Al_2O_3, SiO_2, ZnO & SnO_2				
19	Silver-Doped Zinc Oxide as a Nanofiller for Development of Poly(vinyl alcohol)/Poly(vinyl pyrrolidone) Blend Nanocomposites	first published on 08 January 2016, https://doi.org/10.1002/adv.21650.	2016	MT Ramesan , Meghana Varghese, Jayakrishan P & Pradeepan Periyat	Applications of nanofiller polymer blends
20	Energy storage properties of PVDF torpolymer / PMMA blends	171-174,23977264, IEEEP	2016	*Bagin Chu ; Yang Zhou*	dielectric breakdown field of blends is improved as a result of enhancement of elastic modulus of blends
21	Silver doped zinc oxide as a nanofiller for development of poly (vinylalcohol)/poly(vinylpyrrolidone) blend nanocomposites	Advances in Polymer Technology	2016	M.T. Rameson, Meghana Varghese, Jaya Krishnam P., Pradeep Periyat	Application of nanofillers
22	Largely enhanced thermal conductivity and high dielectric constant of Poly(vinyldene fluoride) / Boron Nitride composites achieved by adding a few carbon nano tubes	The Journal of Physical Chemistry C 2016 120 (12), 6344-6355.	2016	Yan-jun Xiao, Wen-yan Wang, Ting Lin, Xi-jia Chen, Yu-tong Zhang, Jing-hui Yang, Yong Wang, and Zuo-wan Zhou	Large enhanced thermal conductivity and high dielectric constant
23	Electrically conductive thermoplastic polurethane/ polypropylene nanocomposites with selectively distributed graphene	Polymer 2016 97, 11-19	2016	Yan Lan, Hu Liu, Xiaohan Cao, Shuaiguo Zhao, Kun Dai, Xingru Yan, Guoqiang Zheng, Chuntai Liu, Changyu Shen, Zhanhu Guo	Thermoplastic applications
24	Enhancing the electrical	European	2016	Yamin Pan, Xianhu Liu,	Enhancing

	conductivity of carbon black filled immiscible polymer blends by tuning morphology	Polymer Journal 2016 78, 106-115.		Xiaoqiong Hao, Zdeněk Starý, Dirk W. Schubert	the electrical conductivity
25	Metal Oxides Collection	Journal of Physics: Condensed Matter 27, 303001,	2015	Niklas Nilius	Properties of metal oxides
26	Dynamic theology and dielectric relaxation of PVDF/PMMA blends	Composites Science & Tech, Vol. 106.	2015	Y Zhang ; M Zuo; Y Sang ; X Yan;, Q Zhing	Properties of blend PVDF/PMMA
27	Optimization of Dielectric Constant of Polycarbonate/Polystyrene Modified Blend by Ceramic Metal Oxide	Polymer – plastics technology & engineering, volume 54, Issue – 4.	2015	Moumita Khutia, Girish M. Joshi, Kalim Deshmukh & Mayank Pandey	Optimization of Dielectric Constant
28	Cooperative and structural relaxation in PVDF/PMMA blends in the presence of MWNT's	Macro Molecules,47(4), 1392 -1402	2014	Maya Sharma; Giridhar Madras; S. Bose	Application of blend on different structure
29	Electrical properties of PVP/PAM blend thin film at different temperature range from 305- 345K covering a frequency range from 102- - 105 Hz	Matt. Science, Vol. 37,	2014	A Rawat, HK Mahawar, A Tanwar & PJ Singh	Electrical properties at different temperature and frequency
30	Massive electrical conductivity enhancement of multilayer graphene / polystyrene composites using a nanoconductive filler	ACS Applied Materials & Interfaces 6 (19), 16472-16475	2014	Indrani Chakraborty, Kevin J. Bodurtha, Nicholas J. Heeder, Michael P. Godfrin, Anubhav Tripathi, Robert H. Hurt, Arun Shukla, and Arijit Bose	Massive electrical conductivity enhancement of multilayer graphene / polystyrene composites using a nanoconductive filler
31	Excellent dielectric properties Of polyvinylidene fluoride composites	Applied Science and Manufacturing 67, 252-258	2014	Jin Sun, Qingzhong Xue, Qikai Guo, Yehan Tao, Wei Xing	Excellent dielectric properties

	based on sandwich structured MnO_2 / graphene nanosheets/ MnO_2				
32	Electrically conductive multiphase polymer blend carbon- based composites	Polymer Engineering & Science 54 (1), 1-16	2014	Paul J. Brigandi, Jeffrey M. Cogen, Raymond A. Pearson	Study of electrical properties
33	Preparation of poly(vinylidene fluoride) films with excellent electric property by adding a quaternary phosphorus salt functionalized graphene	Composites Science and Technology 91, 1-7.	2014	*Jianchuan Wang, Jieli Wu, Wei Xu, Qin Zhang, Qiang Fu*	Excellent electric property, improved dielectric property and dominant polar crystalline forms
34	Ferroelectric phase diagram of PVDF: PMMA studied and developed	Macromolecules45(18), 7477-7485	2012	Mengyuan Li, Natelite stingelin , jasper J Michels, Mark – Jan Spikman, Kamal Asadi, kirill Feldman, Paul WM Blom, Dago M de Leeuw	Study of blendsPVDF/ PMMA
35	Polymer supported metals and metal oxide nanoparticle synthesis	Journal of nanoparticle research, 14: 715.	2012	Sudipta Sarkar; E. Guibal; F. Durgnard; A.K. Sengupta	characterization & applications polymer metal and metal oxide
36	Dielectric Properties of PVDF- TrFE/ PMMA: TiO_2 Multilayer dielectric thin films	Advanced Material Research, 576(2012): 582-585,	2012		Study of dielectric properties(ε' – no effect, ε - 7.9- 7.6)
37	Studies on electrical conductivity and dielectric behaviour of PVdF–HFP–PMMA–NaI polymer blend electrolyte	Bull. Mater. Sci., Vol. 35, No. 6, November 2012, pp. 969–975	2012	S K Tripathi, Ashish Gupta and Manju Kumari	Study electrical conductivity and dielectric behavior
38	Electrical conductivity by changing phase	ACS Applied Materials &	2011	Zhaohua Xu, Yaqiong Zhang, Zhigang Wang,	Enhancement of electrical

	morphology for composites consisting of Polylactide and Poly(ε- Caprolactone) Filled with acid-oxidized multiwall Carbon nanotubes	Interfaces ,3 (12), 4858-4864		Ning Sun, and Heng Li	conductivity by changing phase morphology for composites
39	Piezoelectric properties and dielectric losses in PVDF- PMMA blends	Journal of Ferroelectrics, Pg. 61-70, Vol. 60, 1984 Issue 1	2011	C. Domenice; D De Rossi; A. Narmini & R. Verma	Study of dielectric losses and piezoelectric properties
40	Dielectric study of the crystal amorphous interphase in PVDF/AMMA blends	Polymer Vol. 35 Issue 3, 475-479.	2011	Hiromu SanteBernd Sluhn	Study of dielectric properties of the polymer blends
41	Nanotechnology with Soft Materials	anie.200200546	2017	Dr. I.W. Hamley	Mankind is now able to design materials at the nano scale, whether through atom by atom or molecule by molecule methods (top, down) or through self organization(bottom, up
42	Electrical properties and structure of polymer composites with conductive fillers, Filled polymer blends: influence of morphology on spatial distribution of filler and electrical properties	National Academy of Sciences of Ukraine, Kiev, Ukraine, yemamun@i.kiev.ua	2010	Ye. P. Mamunya	Study of electrical properties
43	Preparation of polymer based nanocomposites by different routes	Polymers and Composites/I3N	1984	M. Oliveira and A.V. Machado	Methodologies of polymer preparations

Significance of Proposed Research:

Electrical energy storage plays a key role in mobile electronic devices, stationary power systems, hybrid electric vehicles, and pulse power applications [P-9]. In particular, there is a growing need for capacitors that can accumulate a large amount of energy and then deliver it nearly instantaneously. This kind of “pulse power” is needed for a variety of military and commercial applications. Over time, these applications demand ever higher energy and power densities as well as higher rate capability.

These materials shall have potential application in actuators, sensors and power generation. They are of great interest because theirelectrical properties can be tailored by properly choosing the components and their relative concentration. The possible application of these polymer blend composites would be as capacitors, self-regulating heater, over temperature protection devices, antistatic materials for electromagnetic interference shielding of electronic devices, electrical conductive adhesives and circuit elements in microelectronics [P-2,9,10,11]

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