A Dielectric Elastomer and Graphene Nanocomposites: A Review

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Abstract. This paper reviews the developments in dielectric elastomer actuator technology for several applications. Dielectric elastomers are a variety of electroactive polymer that deform when subjected to the electric field and are best suited for the designing of wide range of sensors, actuators and bio medical equipments in comparison to piezoelectric materials, shape memory alloys, ionic polymer metallic materials and shape memory alloys because EAPs are light, adaptable, simple to process, economical ,and can be fit in with confounded surface and geometries The main disadvantage of this material is the operating electric field is very high and the dielectric constant is very low. There is one way to solve this issue is by using of highly conducting materials as a filler material like graphene oxide (GO)/ reduced graphene oxide (rGO) or functionalized graphene oxide. EAPs composite with generally low operational voltage (on the request for 50 V/µm) presently permit us to create actuators dependent on this material. The use of these materials as actuators to drive different control, versatility and automated gadgets includes multidiscipline including materials, science, electro-mechanics etc. The present review highlighted the working principle and actuation mechanism of the electroactive polymer (EAPs) which also identified some of the challenges which are associated with these materials.

1. Introduction
Advancement of polymer based fiber actuators that are fit for changing their shape, size, volume or dimensions when subjected to the electric field [1]. The actuator fiber it tends to be used as building hinder for a few, new things running from clinical prosthetics to astute material structures. The dielectric elastomers offer the most assurance and execution characteristics like natural muscles in various respects. DE based fiber actuators may be most proper not only for the improvement of significantly adaptable, light weight mechanical self-sufficiency and controllers yet what's more for the headway of insightful, multi-commonsense and responsive material structures. Thermoplastic DEs are to be used as fiber-framing actuator material and multi-portion fiber game plan development will be used for assembling these fibers. In order to improve the actuator fiber structure and understand the effect of helper/materials parameters expansive constrained segment assessment will be finished [2] [1]. “Polymer nanocomposites are two-stage materials in which one of the parts (filler) at any rate is in the nanometer scale. There are three kinds of nano fillers. Initial one is the nanoparticles in which each of the three measurements are in nano scale e.g., semiconductor, metal nanoparticles, colloidal
scattering of polymers and so on as shown in figure no. 1” [3] [4] [5]. “Second one is the two dimensional nanomaterials where in two components of the filler are in nanoscale. Models are nano cylinders and cellulose bristles that have the third measurement bigger, shaping prolonged structures” [6] [7]. “The third assortment includes the nano muds, which are platelet formed, with one measurement in nanoscale. This group of nanocomposites can be called as the polymer/mud nanocomposites. The dirt mineral based nanocomposites are broadly researched on account of the characteristic plenitude, lesser expense and high mechanical quality and compound obstruction. The intercalation science among earth and polymer has been generally examined” [8] [9]. “The scattering of the nanosized particles in the polymer grid results in extraordinarily improved mechanical, warm, optical and physico-compound properties when contrasted with immaculate polymer as first appeared by Kojima and collaborators for nylon” [10]. Polymers that react to outer improvements by changing shape or size have been known and read for a very long while. They react to boosts, for example, an electrical field, pH, an attractive field, and light. These astute polymers can all in all be designated "Dynamic Polymers". Polymers and polymer-composites are ending up being the "materials" of current time [11]. Numerous new polymer-based inventive material advances, named as "Savvy Materials", are fit for self-sufficient reaction to changing ecological improvements, through inserted detecting and reaction capacities. In the most recent decade, another class of materials called electroactive polymers (EAP) has risen that react to outside electrical incitement by showing a noteworthy shape or size removal. Electronic EAPs react because of electro-static or Coulomb powers - created on utilization of an electric field, anyway ionic EAPs are driven by versatility or dissemination of particles. Normal EAPs are ionic polymer-metal composites (IPMC), ferroelectric polymers, single-divider carbon nanotubes directing polymers and elastomers, otherwise called dielectric elastomers. Electronic EAPs display prevalent properties than ionic EAPs as far as their high incitation strain, dependability and sturdiness, productivity, and reaction time. Among electronic EAPs, dielectric elastomers have demonstrated the most encouraging properties. Dielectric polymers or D-EAPs have preferred execution over different EAPs as far as their incitation strain, reaction time, high vitality thickness, and high proficiency. All in all, acrylic elastomer is known to be prevalent regarding its most noteworthy areal incitation strain (~160 %), most noteworthy flexible vitality thickness (3.4 MJ/m²), and most noteworthy weight (7 MPa). Be that as it may, practically all the D-EAPs revealed so far are inferred structure homopolymers, for example, acrylic, silicone, and polyurethane. By and large, the entirety of the D-EAPs require high electric field for activation comparative with ionic EAPs. Some are not effectively processable or shapeable into helpful gadgets.

![Figure 1](image-url) **Figure 1** The presentation of a unimorph with one electro-strictive P(VDF-TrFE) copolymer layer of 22 mm clung to an inactive polymer of a comparable thickness: (a) the picture shows the unimorph without electric field; (b) the picture shows the incitation of the unimorph under an electric field of 65 MV/m² (Bar-Cohen, 2004).

Previously, very high working voltages (~ 200 Volt/mm) and very low execution qualities (greatest strain feasible, most extreme vitality thickness and coupling effectiveness) restricted the utilization of EAPs. Ongoing advancements for the structure of EAP composites with generally very low working voltages (~ 10 Volt/mm) presently allow us to create actuators dependent on these materials that can finish with regular magnetic and piezoelectric actuators in execution and cost and
can be utilized for creating complex frameworks, for example, fake muscle, scaled down robots mirroring organic frameworks (for example bugs), or biomedical instruments for directing non-intrusive medical procedures. Despite the fact that, various tests have been led to portray the conduct of EAP composites, the hypothetical comprehension of these materials is fairly restricted. Since, models anticipating by and large reaction of EAP composites as an element of their microstructure are vital to ideal structure of EAP actuators, improvement of such models will be the fundamental point of this work. Also, improved comprehension of EAPs increased through this work, will be utilized in structuring the legs (or wings) for scaled down robots appropriate for remote observation [12].

[13] Detailed that “the High vitality electrons (1.0-2.55 MeV) illumination was utilized to adjust the stage extreme conduct of poly(vinylidene fluoride-trifluoroethylene) copolymers trying to fundamentally improve the properties of the copolymers. It is discovered that the copolymers under an appropriate light treatment display almost no room temperature polarization hysteresis and extremely enormous electrostrictive strain (the longitudinal strain of -5% can be accomplished). Due to the huge anisotropy in the strain reactions along and opposite to the polymer chain, the transverse strain can be turned over an expansive range by shifting the film extending condition. For unscratched films, the extent of transverse strain is roughly about/under 1/3 of that of the longitudinal strain, and for extended movies, the transverse strain along the extending course is equivalent to the longitudinal strain. Notwithstanding the high strain reaction, the lighted copolymers additionally have high flexible vitality thickness and mechanical burden capacity as demonstrated by the moderately high versatile modulus of the copolymer and the high strain reaction of the transverse strain much under 40 MPa malleable pressure” [14]. “The high strain and high flexible modulus of the lighted copolymer additionally bring about an improved coupling factor where the transverse coupling element of 0.45 has been watched”.

[15, 16] [17] Reported the “Principle of Maxwell pressure. At the point when a voltage between the consistent anodes is applied a weight emerges, and the Elastomer packs while it grows in the plane and furthermore referenced that the reaction is accepted to be because of Maxwell stress (as shown in figure no. 2), a quadratic reliance of the worry upon applied electric field. Estimations of the dielectric consistent of extended polymer uncover that the dielectric steady drops, when the polymer is stressed, demonstrating the presence of a little electro-strictive impact. At long last, estimations of the electric breakdown field were made. These additionally show reliance upon the strain. In the unstrained express the breakdown field is 20 MV/m, which develops to 218MV/m at 500-500% strain. This huge increment could end up being of significance in actuator structure.

Figure 2 (i) Dielectric elastomer (EAPs) operating principle. (b) The geometry of the proposed EAP based actuator.

[4] [18] [19] Investigated “the circular strain test gauges the extension of an impelled hover on a bigger extended film. The photo shows 68% zone expansion during incitation of a silicone film. Direct strain preliminary of HS3 silicone film with a high level pre strain for the field off (An) and on (B) with a field of 128 V/µm; 117% relative strain was found in the central region of (B). (C and D) Activation of acrylic elastomers, making about 160% relative strain, for the Field off (C) and on (D); the dull region in (C) shows the dynamic zone. The Figure is a sketch of an elastomer film (light
diminish) stretched out on an edge (dim) and structured with an anode (mid-diminish). Subsequent to applying a voltage, the dynamic piece of the elastomer expands and the strain can without a lot of a stretch evaluated optically”.

[20] [21] This paper presents “another delicate actuators dependent on electroactive polymers (EAPs) innovation. The actuators made out of a pre-extended silicone film faltered with a flimsy gold film on the two sides, filling in as cathodes. A specific collapsed geometry, executed through an imaginative manufacture process, permits to misuse the electro-strictive impact and to grow delicate actuators appropriate in numerous applications where delicateness and adaptability are vital. These actuators were described by estimating the compression versus the applied voltage, indicating great outcomes. Specifically, a withdrawal of 2% was acquired with an excitation voltage of 2000 V. Also, by utilizing the proposed model, it is conceivable to gauge the presentation of the actuators with various geometrical parameters”.
[22] Represented that the carbon nano-filaments (CNFs) were utilized to improve the exhibition of suffocated poly(styrene-b-[ethylene/butylenes]-b-styrene) (SSEBS) composite actuator as shown in figure no. 3. The outcomes show that carbon nanofibers were homogeneously scattered in the SSEBS polymer network without nearby agglomeration.

**Figure 3** Schematic delineation of a D-EAP previously (top) and after (base) electrical incitation. Electro-static fascination between the oppositely charged consistent terminals applied to restricting surfaces of the D-EAP produces a typical Maxwell worry upon activation and packs the movie in the transverse (z) bearing. Under isochoric conditions, the movie broadens horizontally along the x and y bearings. The thickness of the agreeable anodes is overstated here for clearness.[23] [5]

[23]: Utilized Process chart delineating estimation of the blocking power created by a D-EAP upon electrical activation. In (an), a film is limited (an) isotropically along and y at foreordained strain increases ($\Delta \varepsilon = 25\%$) up to $\varepsilon_{\text{max}} = 275\%$. The plastic installation appeared in (b) is rushed on the two sides of the prestrained film to secure in the biaxial twisting, and the apparatus is then exposed to uniaxial pliable stacking along y to accomplish a foreordained last anisotropic prestrain in (c). The
example is then covered with an agreeable anode on the two sides (d) and in this manner exposed to an outside potential (e) to initiate transverse pressure and horizontal incitation, which brings about a quantifiable power decrease in the y bearing. The current work looks at the mechanical and incitation reaction of these nanostructure polymer (ENP) frameworks under semi static, and stacking conditions. In this examination it is that researched the mechanical properties of the benchmark DEAP specifically, the VHB 4910 acrylic elastomer, and novel ENPs made out of swollen tri square copolymers prior and then afterward as shown in figure no. 3.

[24]: Announced that “the impact of fiber courses of action in the grid. In this paper the creep deformation of both short fiber and consistent fiber composite is to be appeared. The limited component procedure and the flexible viscoelastic correspondence guideline techniques have been utilized to figure the powerful drag properties of SCS6 (fiber)/Sic (framework) composites and the outcomes have been looked at. Game plans of fiber were utilized to consider the impacts of fiber courses of action on the wet blanket properties of the composite. Impacts of the fiber volume part on the drag conduct of composite were additionally considered. No critical contrast was found in the longitudinal (consistence along the fiber axis).it was discovered that the fiber game plan assumes a significant job in the transverse consistence and transverse shear consistence. Five diverse hypothetical techniques were utilized to compute the viable properties of the unidirectional fiber strengthened composite. Out of these five strategies, two depended on the comparing standard and the other three were bases on the FEM”.

[25][26]: Investigated the reaction of the polyurethane elastomer at room temperature and in the temperature run close to the glass progress where the movements of the delicate sections are solidified out. It was discovered that the Maxwell stress commitment to the strain reaction can be noteworthy at temperatures higher than the glass progress temperature. Furthermore, the material additionally displays a huge electro-strictive coefficient Q, around two sets of greatness higher than that of PVDF. It was likewise discovered that the Q shows little change in the glass progress temperature district, while the flexible consistence changes by more than one request for greatness demonstrating that the backwards corresponding connection between the versatile consistence and the Q probably won't be widespread. The test results likewise show that for the polyurethane elastomer examined, the temperature recurrence superposition guideline can be applied to both the dielectric and versatile information, while the difference in the electro-strictive coefficient with temperature and recurrence follows this superposition standard.

[8]: Reported that new class of all-natural field-type EAP composites, which can show high elastic energy densities prompted by an electric field of just 13V mm21. The composites are created from a natural filler material having high dielectric constant scattered in an electro-strictive polymer framework. The composites can show high net dielectric constants while holding the adaptability of the network. they chose a metallo-phthalocyanine (MtPc) oligomer, copper-phthalocyanine (CuPc), as the filler of high dielectric constant(>10,000).For composites containing 40wt%to 55wt% of CuPc, which display high dielectric steady while the dielectric misfortune stays low, the versatile modulus at room temperature is in the scope of 0.6 GPa to 1.2 GPa. For composites containing 40wt%to 55wt% of CuPc, which display high dielectric consistent while the dielectric misfortune stays low, the flexible modulus at room temperature is in the scope of 0.6 GPa to 1.2 GPa. Watched The outcomes show that this all-natural composite methodology can bring about an in excess of multiple times decrease in the applied field contrasted and the other field type EAPs with comparative strain and versatile vitality. For the flow composite, the applied field of 13 V/µ m relates to the breakdown field of the material (the most elevated field that can be applied to the material without electrical shorting), which can be expanded by improving the composite quality through further examination on composite manufacture techniques. At fields lower than 10 V/µ m, the composite can be worked more than a few hours without changes in the strain response.

[27][28]: Proposed a spring-component model (SCM) for the Monte-Carlo recreation of unidirectional fiber-strengthened composites. This technique endeavors to change the nonlinear balance condition into a direct condition, using an explanatory answer for improve the computational
effectiveness. This likewise empowers us to utilize the direct grid solver and decrease computational expenses. Since SEM legitimately includes a three-dimensional model, it can catch the precise three-dimensional pressure field, dissimilar to a ZC model. The determined pressure appropriations concur with 3D FEM outcomes detailed in the writing. They found that this technique is more productive than our past SLM approach as shown in figure no. 4. The proposed strategy is figured in the grid structure and is good with basic examination, (for example, FEM) in the designing field. This examination proposes a numerical technique for breaking down and reproducing the disappointment of unidirectional fiber-strengthened composites utilizing the spring-component model (SEM). and also they differentiate the result between the proposed SEM and 3D FEM [29-32].

![Figure 4](image)

**Figure 4** Strain grouping of the disappointment plane, standardized by a long shot field strain (Al2O3/polymer composite implanted into Al) [33] [34].

[35]: Investigated in situ polymerization of an aniline salt inside epoxy frameworks was fruitful to plan Polyaniline PANI/epoxy composites with different PANI substance. A PANI/epoxy composite charge bearers inside the composites neglect to stay aware of the electric field of the expanding recurrence. Another impact may add to this unwinding procedure is that the AC conductivity showed at higher recurrence will increment with recurrence and along these lines decline charge putting away ability. The composite containing the biggest measure of PANI demonstrated the most grounded recurrence reliance of dielectric properties, which may be because of its most noteworthy conductivity the hardener type was likewise found as a basic parameter for the dielectric properties of PANI/epoxy composites. The composites relieved with basic sort hardener (amine) demonstrated a low dielectric consistent, and this might be because of the dedoping impact of PANI salt by amine, which can respond arranged in this design displayed a high dielectric steady near 3000, a dielectric misfortune digression under 0.5 at 10 kHz and at room temperature. SEM result likewise recommended that the in situ polymerization strategy to set up the PANI/epoxy composites was helpful to accomplish great scattering and high similarity of PANI with the epoxy network.

[36] investigated the impact of fiber content on the mechanical and warm properties of kenaf fiber strengthened thermoplastic polyurethane composites. In this study a 2D hierarchical finite-element-model of a natural fiber bundle composite is established to investigate the influences of the microstructure of natural fiber bundles to the bulk thermal property of the composite. In the composites fibers are arranged in the doubly periodic order as shown in figure no. 5.
Figure 5 Shows a schematic illustration of a three-level hierarchy composite model, with each natural fiber bundle consisting of lumens and a solid region.

[37] Presented a hypothetical model to explore the mechanical properties of CNT/polymer nanocomposites. A two-advance strategy was introduced to create old style micromechanics hypotheses so as to consider the impact of CNT/polymer interphase on the mechanical properties of nanocomposites. The impact of small scale basic parameters, including agglomeration, cover and peeling of CNTs, on the mechanical properties of nanocomposites was examined utilizing the created micromechanics hypotheses. Two hypothetical methodology have been utilized (Mori-Tanaka hypothesis and self-reliable strategy) to research the general properties of the composites as shown in figure no. 6. The versatile properties of the interphase were resolved by each micromechanics hypothesis and utilized for accurate forecast of the nanocomposite and for considering the impact of microstructural parameters on the mechanical properties of the nanocomposite [38, 39].

Figure 6 Schematic of the process used to determine the effective inter phase.

[40] have been used the finite element method (FEM) to investigate the effects of particle position, shape, orientation, and size distribution on the size-dependent flow strengthening of the SiC/Al composites. The particle size effects on the behavior of metal matrix composites are investigated. In the analysis a two-dimensional models were used for the investigations. The Continuum theory of Mechanism-based Strain Gradient (CMSG) plasticity to investigate particle size effects in metal matrix composites as shown in figure no. 7 [41].
Figure 7 (a) A unit cell model of composite with circular particles. (b) The corresponding finite element model used in the analyses showing the mesh and boundary conditions.

2. Working Principle of Electroactive Polymer

“A class of electrostrictive polymers with low flexible moduli, otherwise called dielectric elastomers, offers by and large execution like organic muscles. Dielectric elastomers (DE) are a subset of materials referred to comprehensively as polymers (EAP). By and large, EAP based actuators prompt high strains contrasted with unbending and delicate earthenware production (EAC). EAPs are better than shape memory amalgams (SMA) in higher reaction speed and low thickness. A complete survey of these innovations is given in a book altered by" [3]. “All the different EAPs, the dielectric elastomers offer the most guarantees and execution attributes like organic muscles in numerous regards. Hence, DE based fiber actuators might be most appropriate not just for the improvement of profoundly versatile, lightweight, robots and controllers yet in addition for the advancement of shrewd, multi-useful, and responsive material structures. The rule of activity of a DE actuator can be spoken to by an equal plate capacitor, and its incitation rule depends on improvement of static weight (p) between two endless supply of a potential contrast. In its easiest structure a film of dielectric elastomeric is covered on the two sides with an agreeable terminal material. At the point when voltage was applied, the subsequent static powers pack the film in thickness and extend it in region, creating high strains over 100%.

An electromechanical incitation instrument is an actual cycle whereby a mechanical framework is enacted by applied electric field. Two components, electrostriction and Maxwell's pressure impact, are viewed as prime supporters of the huge electric-field-initiated strain displayed by electronic EAPs. The subsequent burdens and strains identifying with the two components display a quadratic reliance on an applied electric field. The strain reaction of an elastomer can be contributed by both of them, just like the instance of dielectric elastomers or the two of them.

2.1 Electrostriction

Electrostriction emerges because of the adjustment in dielectric properties of the material with strain, i.e., there is an immediate coupling between electric polarization and mechanical strain reaction. [42]

\[ S_{\text{electrostriction}} = -Q\varepsilon_0\varepsilon_r(\varepsilon_r-1)E^2 \]  

(1)

Condition (1) relates \( S_{\text{electrostriction}} \), the strain in the thickness course of the film because of electrostriction to the electrostrictive coefficient \( Q \) the permittivity of free space \( \varepsilon_0 \), the relative permittivity \( \varepsilon_r \), and the applied electric field \( E \). The general permittivity regularly alluded to as the dielectric consistent \( \varepsilon_r \) is given by the proportion of the permittivity of a material \( \varepsilon \) to the permittivity of a vacuum \( \varepsilon_0 \).

2.2 Maxwell Stress Effect

The Maxwell stress impact is a result of an adjustment in electric field dissemination inside the dielectric with strain and is exclusively liable for the activation of simply shapeless polymers. On the other hand this might be deciphered as Coulombic fascination between inverse charges on electrodes.
\[ S_{\text{Maxwell}} = -s \varepsilon_0 \varepsilon_r E^2 / 2 \]  

Condition (2) relates the strain in the thickness direction of the film \( S_{\text{Maxwell}} \) to the versatile consistence \( s \), the permittivity of free space \( \varepsilon_0 \), the relative permittivity \( \varepsilon_r \), and the electric Field \( E \). [4] “proposed a connection between the actuation pressure \( p \) to the relative permittivity \( \varepsilon_r \), the permittivity of the free space \( \varepsilon_0 \), applied electric field \( E \), the applied voltage \( V \), and the thickness of the material \( t \).

\[ p = \varepsilon_0 \varepsilon_r E^2 = \varepsilon_r (V / t)^2 \]  

“A wide range of setups of DE actuators have been accounted for in the writing. Quite compelling are rounded or barrel shaped actuators proposed by” [43] [3] and [44]. However, in both cases, the tubular actuator was manufactured using elastomeric tubes with two layers of electrodes added to the inner and outer surfaces of the tubes by dip coating or by smearing conductive particles with polymer-based material. “Fiber-fortified polymeric composites are by and large dominatingly utilized since 10 years in numerous basic parts in the airplane, car, marine and different ventures as a result of their high quality, high solidness to weight proportion and low thickness. Customary auxiliary materials display isotropic conduct i.e., they show equivalent properties regardless of the course of estimation. Nonetheless, the properties of fiber fortified composites firmly rely upon the heading of estimation. It has been demonstrated in the past that the quality and modulus of fiber-strengthened composites achieve a greatest when they are estimated the longitudinal way of the fibers” [45]. At some other point of estimation these properties are lower, the base being seen at 90° to the longitudinal heading of filaments (transverse direction).

3. Classification of Electroactive Polymer
(i). Electronic EAP Materials – “These are mostly materials that are dry and are driven by the electric field or Coulomb forces. This category includes piezoelectric, electro-strictive and ferroelectric materials. Generally these materials are polarizable with the strain being coupled to the electric displacement. The strain of electro-strictor and ferroelectric materials is proportional to the square of the polarization or electric displacement. In piezoelectrics materials the strain couples linearly to the applied field or electric displacement. Charge transfer in these materials is in general electronic and at DC field these materials behave as insulators. These properties have been studied for over a century in single crystals and for over 3 decades in polymers. Another group of EAP materials that belongs to this class are dielectric polymers, which are mechanically very soft and easily compressed by the Coulomb forces associated with electrode charge. The strain in these materials is nominally proportional to the square of the polarization” [46].
(ii). Ionic EAP Materials – “These materials usually contain an electrolyte and they involve transport of ions/molecules in response to an external electric field. Examples of such materials include conductive polymers/polyaniline actuators, IPMC, and ionic gels. The field controlled migration or diffusion of the various ions/molecules results is an internal stress distribution. These internal stress distributions can induce a wide variety of strains from volume expansion or contraction to bending. In some conductive polymers the materials exhibit both ionic and electronic conductivities. These materials are relatively new as actuator materials and have received much less attention in the literature than the piezoelectric and electro-strictive materials. At present, due to a wide variety of possible materials and conducting species, no generally accepted phenomenological model exists and much effort is underway to determine the commonalities of the various materials systems. A clearer understanding of the characterization techniques would help immensely in determining underlying theories and scaling laws for these actuator materials” [46]. “The most widely used piezoelectric ceramics, can generate large stresses with reasonably good coupling efficiencies (>50%) at relatively low electric fields (<5V/µm). However, the deformations they can generate are quite small (the maximum attainable strain is ~ 0.2%). On the other hand, relaxor PT single crystals such as PZN-8%PT, in which hysteresis losses arising from ferroelectric behavior are drastically reduced, exhibit far superior properties. In fact, there is almost an order of magnitude difference in maximum attainable strain and energy density in PZN-PTs and PZTs. However, PZN-PT single crystals are expensive and
difficult to fabricate and therefore used mainly only in high performance devices. In contrast to piezoelectric ceramics, the dielectric elastomers such as PU and silicones can exhibit large deformations (with maximum attainable strain up to 40%) with reasonably high energy densities and coupling efficiencies. However, the maximum pressure exerted by dielectric elastomers is relatively small (on the order of 1 MPa) and the operating electric field is quite high (>150V/µm). Interestingly, Silicones exhibit properties that are very similar to those for human muscle. Among Poly(vinylidene fluoride-trifluoro ethylene) P(VDF-TrFE) based electro-strictive polymers, P(VDF-TrFE-CFE) exhibits the best performance characteristics. It can not only exert large stresses (on the order of 50MPa) like piezoelectric ceramics but also undergo considerable deformations like dielectric elastomers (with strains to the tune of 5%). Furthermore, they can achieve high energy densities and can operate with good coupling efficiencies. Nevertheless, like dielectric elastomers they suffer from the drawback that the operating electric field is quite high (>100V/µm). Surprisingly, however, this drawback in dielectric elastomers and electro-strictive polymers can be overcome with ease by constructing composites of actuator materials with high dielectric constant organic nano-fillers. For example, by constructing a nanocomposite of PU with 3.5 vol % copper pthalocyanine (CuPc), the dielectric constant of the elastomeric system can be increased from 7 to 1000. Consequently, the operating electric field can be brought down from 160V/mm to 11.5V/mm" [47] [3].

4. Applications
The advantages of dielectric polymer, specifically, are the huge electromechanical bowing at low voltages [48], and their delicate, adaptable structures. This permits them to impersonate the movement of organic muscles, and be utilized in watery conditions [49] [50]. Commonplace advantages of DEAPs incorporate low flexible firmness and high dielectric steady, enormous disfigurements, huge energy show efficiencies, lightweight and low commotion [51]. Advantages can likewise shift contingent upon the materials and techniques utilized, just as the seller. For example, Parker Hannifin [52] says their EAP innovation offers a few focal points when contrasted and customary innovation. They quote ultralow power utilization, 10X extra battery life, quiet activity and a stretchable polymer with up to 20% working strain for actuators. Then again, Arkema creates forte fluorinated EAPs (terpolymers), which can store a lot of energy and brag bigger changes in the size and the shape [53]. Different organizations fabricate EAPs, so make certain to do your exploration prior to choosing a seller [54, 55]. The uses of EAP actuators are various. They’ve gotten significant consideration as delicate biomimetic actuators in bioengineering applications like counterfeit muscles and dynamic catheters. Because of the solidness of their anodes (utilizing the honorable metals Pt or Au), they’re likewise valuable for submerged mechanical applications and oceanic propulsors, where consumption opposition and quick actuator reaction are important. DEAP actuators have potential in acoustic applications, for example, sound age, and commotion and vibration control in amplifiers [51].

5. Conclusion
The innate behavior of rubbers shows great potential for the development of electro-active materials as dielectric elastomer actuators. Despite the fact that these materials have deficiencies, for example, low dielectric constant and weak mechanical strength however the solution to the issues isn't so confounded, which one of the most effective procedures is the utilization of composites. To advance functional application, high dielectric constant is important to reduce the necessary electric field to create adequate strain and elastic energy. Successful dielectric constant of polymer composites is essentially higher than the dielectric constant for the lattice polymer just at permeation volume division portion if charge infusion impacts are missing or low. Nano composites can have epic dielectric constants if huge charge infusion impact is available. Just a single method to expand the dielectric constant of the electroactive polymer is by filling the high charge conducting filler particles.

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