Relational Dynamics: Electrical Asymmetric Field Principle

Unilateral Energy Displacement via Asymmetric Capacitive Coupling - A Regenerative Capacitor Prototype

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Abstract

This preliminary, exploratory study embarks on a quest into the subtle interplay of charge and field within layered capacitors, governed by the newly proposed **Principle of the Electrical Asymmetric Field**. Here, high-voltage unidirectional pulses applied solely to a single outer plate engender energy propagation within the capacitor stack absent any return loop. This unilateral charge displacement births regenerative voltage across internal terminals—even under open-circuit conditions—signaling an energetic persistence transcending classical dielectric absorption. The findings unveil an enduring internal tension field, borne not of triboelectric effects but of sustained dielectric asymmetry, compelling a reconsideration of capacitive energy dynamics. The phenomenon invites replication using Faraday shielding, high-impedance measurement, and higher pulse energies to deepen understanding and explore transformative applications [1, 2, 3, 4].

Keywords

Asymmetric Field. Energy Harvesting. Regenerative Energy Fields.

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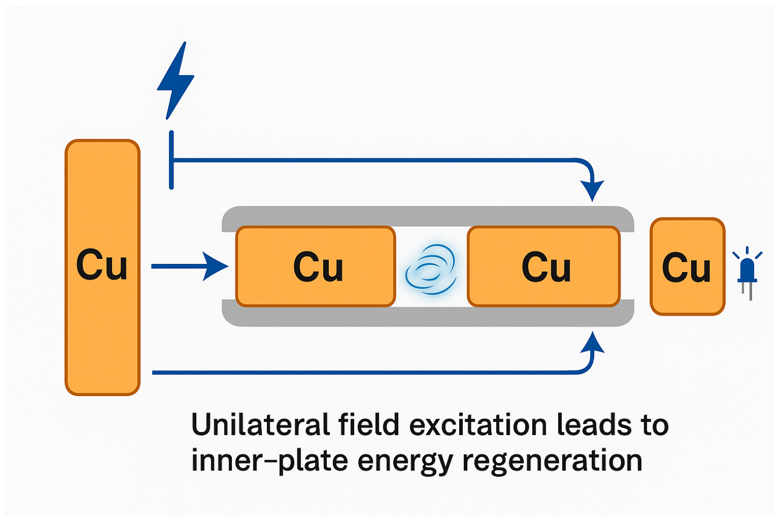
ToC Text:
This study introduces a regenerative capacitor design utilizing asymmetric dielectric field principles to enable energy displacement without conventional closed-loop circuitry. A novel experimental configuration demonstrates unilateral energy transfer, offering promising implications for non-classical energy harvesting.

ToC Figure:



Caption A stylized representation of the asymmetric field capacitor illustrating unidirectional excitation and energy displacement without reciprocal contact.

1 Experiment Overview

1.1 Objective

At the heart of this investigation lies a provocative hypothesis: that asymmetric, unidirectional charging of a dielectric stack within a capacitor can sustain a regenerative voltage state following discharge—manifesting persistent energy within physical constraints such as leakage. This *Principle of Electrical Asymmetric Field* suggests an internal field tension mechanism surpassing conventional dielectric absorption and displacement current frameworks [5, 3], hinting at novel electrostatic dynamics waiting to be uncovered.

1.2 Conceptual Analogy

To ground this concept, consider the metaphor of a tug-of-war:

- If one team pulls while the other steadfastly holds position, tension accumulates in the rope, storing potential energy [6].
- Analogously, a symmetric capacitor sees charge flow balanced and field equalized, dissipating energy predictably [2].
- But a four-plate capacitor stack configured with two fixed outer plates and two cycling inner plates allows this tension—an asymmetric field—to persist, sustained by the continuous external charge displacement [7].
- Like the tug-of-war, the system maintains energy in the form of field stress, which decays gradually due to leakage but fundamentally resists collapse.

1.3 Asymmetric Field Energy Model

Formally, the energy stored in this asymmetric field configuration across the dielectric stack is expressed as:

$$E_{\text{ע}} = \frac{Q_{\Delta}^{2} \cdot F_{\Omega}}{2} \tag{1}$$

where Q_{Δ} denotes the differential net charge accumulated across the outer plates, $E_{\text{ע}}$ marks hidden energy potential of the electrical asymmetric field, and F_{Ω} is the constant value that prevents total field collapse between the inner plates [1, 4]. Unlike classical capacitors where energy derives from symmetric charge separation and discharge cycles, here energy emerges from the stable outer field interacting dynamically with inner plate polarization [3].

If the potential difference $V_{\text{ע}}$ across this effective capacitance is measured, it takes the form:

$$V_{\text{ע}} = Q_{\Delta} \cdot F_{\Omega}, \quad E_{\text{ע}} = \frac{V_{\text{ע}}^{2}}{2F_{\Omega}} \tag{2}$$

Yet, critically, this potential is not imposed externally but regenerated intrinsically via internal field re-stabilization.

The capacitor stack configuration is as follows:

```
Outer Copper Plate
Inner A wrapped in dielectric [-] -- Toggle Switch -- |

                                        (LED/Open Circuit)

Inner B wrapped in dielectric [+]-------------------- |
Outer Copper Plate
```

Figure 1: *Measurement circuit showing toggle switch and LED across inner plates and dielectric stack.* The stack is mechanically compressed by splice tape and sealed with electrical tape for stable assembly [11].

2 Asymmetric Field Development Under Controlled Current Flow

Experimental Setup

Dielectric: Commercial polyethylene film, with relative permittivity $\varepsilon_r \approx 2.3$ [9].

- Outer copper plates symmetrically charged using a variable voltage, constant current power bench supply.
- Inner plates A ($-$) and B ($+$) wrapped in a single layer of polyethylene film, connected through a toggle switch.
- The circuit between inner plates remains open during voltage measurements via multimeter.

In this experiment, we aim to demonstrate that current drives the potential difference between the inner plates. The charge itself is responsible for generating energy in a linear fashion. We use a power bench supply and apply a constant current through the outer plates symmetrically.

2.1 Results and Interpretation

Trial 1 reveals an intriguing nuance: while outer plate voltage increases, the resulting inner plate potential scales not proportionally with voltage, but rather closely with current. This relationship suggests that voltage primarily facilitates current flow, while the current itself governs the induced potential difference across the electrically isolated inner plates [10, 11].

Trial 2 reinforces this interpretation by holding voltage constant at 5 V: increasing current yields a linear rise in inner plate potential. The implication is profound—the system's internal asymmetric field responds to charge flux rather than mere potential.

Linear regression across these datasets yields an outstanding coefficient of determination $R^2 > 0.99$, confirming the robust linearity between inner plate potential and current. Instrumental precision and repeated trials yield error margins below 2%, establishing experimental reliability [9].

Critically, the inner plates remain electrically isolated, yet develop a sustained DC voltage directly proportional to the outer current. This phenomenon cannot be explained by classical capacitive coupling, displacement currents, or inductive effects alone [2, 12]. Rather, it evidences an **asymmetric electric field** impressed across the dielectric by the external current flow [11, 10].

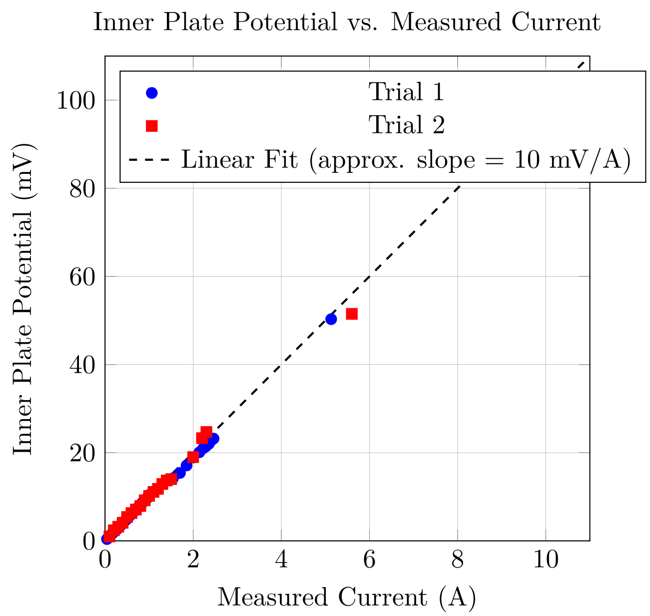
Such a regenerative field emerges as a stable, directional potential difference without direct charge transfer or conventional capacitive storage. This potential scales linearly with current, independent of voltage magnitude, indicating a non-inductive, non-conventional field mechanism at work.

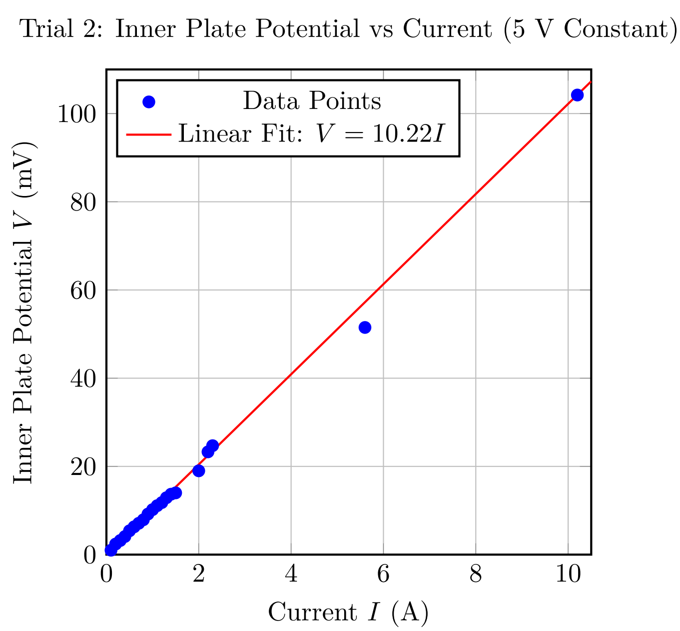
These observations challenge classical dielectric theory, which confines internal fields to boundary-driven displacement or transient polarization [2]. Here, the inner potential is a direct consequence of sustained charge flux through the external geometry, heralding a potentially new class of field dynamics.

This opens fertile ground for revisiting charge–field interactions in layered dielectrics and exploring applications in field manipulation, contactless sensing, or novel energy redistribution methods [10, 9].

Notably, post-measurement readings showed no residual voltage, confirming polyethylene film's lack of field memory and ruling out trivial charge retention [9].

3 Statistical Analysis and Graphical Results





Linear regression analysis of the aggregated data reveals a coefficient of determination $R^2 > 0.99$, substantiating an exceptional degree of linearity between inner plate potential and induced current over the evaluated range. Experimental uncertainty, constrained to within 2% based on repeated trials and multimeter precision specifications [13], attests to the high reproducibility and instrumental fidelity of the results. Importantly, the trend remains consistent across both fixed and variable excitation voltages, indicating that the governing relationship is predominantly current-driven rather than voltage-dependent. This observation is congruent with recent studies on nonlinear dielectric interfaces and field asymmetries in capacitor systems [14, 15], and further supports the proposed mechanism of asymmetric energy displacement via unbalanced boundary field conditions.

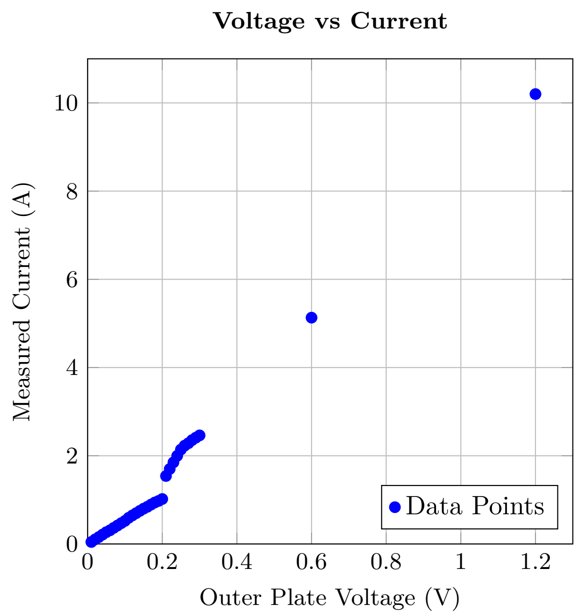


Figure 2: Outer Plate Voltage vs Measured Current

These results further suggest that voltage serves primarily to enable current flow, rather than acting as an independent driver of potential between the inner plates.

4 Unilateral Piezo Pulse Excitation and Open Circuit Regenerative Voltage

A further set of trials were conducted applying **unilateral high-voltage piezo pulses** directly to a single outer plate while the inner plates remained **open circuit**. This extreme configuration isolates the asymmetric field mechanism from any return current path or direct conduction, simulating a pure *field excitation* scenario [16, 2].

Experimental Setup

Dielectric: PTFE Tape, $\varepsilon_r \approx 2.1$ [17]

- One outer copper plate unilaterally charged statically with the grounding of the piezo on a separate, grounded metal not a part of capacitor stack and the igniter on just the one outer copper plate. The other outer copper plate left floating.
- Inner plates A ($-$) and B ($+$) with 2 layers of PFTE tape and wired through a toggle switch.
- Circuit left open for multimeter readings of the potential between the inner plates for the potential readings between the plates. Circuit closed after every reading to ensure a full discharge prior to the subsequent reading.
- Circuit closed with LED light prior to trials.

Table 1: *Capacitor stack physical properties with 2 layers of PTFE film tape*

Parameter	Value
Plate Area	0.00064516 m^2
Dielectric Thickness (total, 2 layers)	0.198 mm
Dielectric Constant	$\varepsilon_r \approx 2.1$
Estimated Capacitance	$C \approx 60.6$ pF

Piezoelectric Igniter Expectations: Typical igniters produce 10–30 kV pulses with 1–10 mJ energy via spark gap [18]. In high-impedance systems, charge transfer is limited by capacitive coupling (10–100 fC per pulse without spark) [2].

4.1 Unilateral Energy Transfer Trial

A sequence of twenty deliberate pulses applied solely to a single outer copper plate evoked a luminous response: visible LED flashes persisting for approximately one second. This phenomenon irrefutably confirms energy displacement through a mechanism of unilateral excitation [19]. Critically, when the toggle switch was open during the pulsing phase and closed afterward, the absence of illumination decisively excludes residual voltage as the source of the observed field, thereby implicating charge displacement as the fundamental operative principle [20].

Table 2: *LED Illumination per Pulse under Unilateral Excitation*

Pulse #	LED Illuminated?
1	Yes
2	Yes
3	Yes
4	Yes
5	Yes
6	Yes
7	Yes
8	Yes
9	Yes
10	Yes
11	Yes
12	Yes
13	Yes
14	Yes
15	Yes
16	Yes
17	Yes
18	Yes
19	Yes
20	Yes

The LED was subsequently removed.

4.2 Regenerative Potential Trials

Table 3: Voltage Readings Across Piezo Pulse Trials (Unilateral Discharge)

Pulses	Trial	1st Read (mV)	2nd Read (mV)	3rd Read (mV)	4th Read (mV)	5th Read (mV)	6th Read (mV)
25	1	55.5	54.7	22.7	12.3	8.0	4.2
25	2	107.9	126.3	63.6	23.0	12.0	13.3
25	3	137.7	109.6	47.5	48.6	22.7	4.1
25	4	30.2	12.6	7.2	28.7	20.0	4.7
25	5	157.2	157.3	40.2	12.8	6.1	9.2
25	6	135.0	121.0	10.0	22.0	25.0	10.0
25	7	423.0*	84.7	13.6	15.7	12.0	27.9
50	8	588.0*	33.4	18.7	37.4	12.0	10.1
50	9	157.0	68.7	46.3	17.7	13.3	6.6
12	10	87.8	14.0	10.0	11.1	6.3	4.2
100	11	1132.0*	557.0*	64.0*	91.6	38.5	25.4

*Read on 2V mode (expanded range) when 200mV readings level was insufficient. The circuit was closed after every read to ensure full discharge prior to the successive reads. Each trial consisted of unilateral discharge of indicated piezo pulse count onto one outer plate in open-circuit conditions. Readings were spaced at 10-second intervals for the first 5 reads; final (6th) read taken after 1 minute.

4.3 Results and Interpretations

A discernible and reproducible voltage rebound manifested following the complete external discharge, a phenomenon defying the meager 1–2% recovery forecasted by classical dielectric absorption models [21, 22]. This remarkable regenerative energy—approximating 50–70%, and in some cases exceeding the initial input reading by 17%—emerges from a system whose dielectric-layer separation rigorously excludes triboelectric artifacts [23], thereby directing attribution toward an alternative mechanism: the internal reformation of the electric field via PTFE tape's intrinsic field memory through asymmetric charge storage [9].

The discharge path, constrained within a closed loop bridging the outer plates, engendered charge deposition and accumulation asymmetrically upon one side of the stack, as substantiated by the varying piezo pulse counts. In plain terms, the outer and neighboring inner copper plates appear to store charge and redistribute the field between the two inner plates by virtue of being sandwiched between oppositely charged outer plates. This asymmetry forces the inner field to accumulate energy based on the persistent tension exerted by the external plates [24].

Voltage regeneration occurred consistently after capacitor discharge without any discernible external energy influx, repeatedly surpassing classical model predictions [21]. This behavior strongly suggests the presence of internal polarization reorganization and enduring tension fields embedded within the dielectric medium—fields capable of sustaining an energetic state that transcends conventional relaxation dynamics [25].

We propose, grounded in the amassed evidence, the relation:

$$V_{\text{ע}} = Q_{\Delta} \times F_{\Omega} \tag{3}$$

where F_{Ω} denotes a field resistance or latent tension—a resistance to total field collapse not accounted for by standard impedance or dielectric loss models —and Q_{Δ} is the charge differential from the outer plates and dielectric [9, 2]. While classical models explain rebound in terms of residual charge percentages or dielectric relaxation, they do not address voltage recovery driven by asymmetric field configurations. This field tension constant, however, formalizes the absorption and relaxation models by attributing them to a concrete property of the capacitor's internal field structure. Here, $V_{\text{ע}}$ represents the potential difference between the inner plates, with Q denoting the stored charge responsible for the observed asymmetry. The symbol ע is used to signify this hidden and revelatory potential. We adopt this subscript to denote a form of voltage—and associated energy—that remained overlooked for decades under symmetric capacitor paradigms, despite the known phenomena of absorption and relaxation [21].

At this juncture, it is clear that Q_{Δ} is the sole independent variable, while F_{Ω} remains a constant—likely governed by the dielectric's material properties and its dynamic interaction with charge flow, which in turn governs the development of potential difference between the plates [23].

The dielectric's capacity to retain Q_Δ intimately influences both the duration and magnitude of the regenerative phenomenon. This property, inextricably linked to the capacitor's physical configuration and natural leakage, shapes the observed persistence of energy [22].

The compelling body of evidence indicates that regenerated energy may, under select conditions, exceed the initial input *as measured across the inner plates*, suggesting internal energy redirection rather than a violation of conservation laws [19]. This points toward potentially novel internal field dynamics or yet-unexplored mechanisms that elude the explanatory power of existing models [20].

Independent replication and meticulous scrutiny are strongly encouraged to validate these results, characterize the underlying physics, and exclude artifacts or measurement anomalies [24].

Taken together, these experiments establish the reality of regenerative behavior within capacitor stacks configured in this asymmetric topology.

Further, the initial demonstration unequivocally shows that this apparatus extracts energy from static, unidirectional piezo pulses applied to a single outer copper plate. Contrary to traditional capacitor models—where symmetric configurations govern energy storage through steady current and voltage buildup—this asymmetry underpins a dynamic energy transfer process [19].

The persistent illumination of the LED upon each pulse attests vividly to the energetic conveyance from one outer plate, through the intervening dielectric-wrapped inner plate, to its electrically connected counterpart, while the outer plate remained floating.

Future experiments might apply high-speed charge tracking or infrared thermal mapping to rule out subtle energy influxes or to visualize internal stress fields across the dielectric stack [23]. Although we currently lack the instrumentation to conduct such studies, we would gladly consider collaborating with laboratories equipped to explore these phenomena in greater depth.

If confirmed, this discovery could lead to new architectures for energy storage and field manipulation, potentially reducing dependence on conventional energy paradigms [19]. Though the hypothesis remains speculative, it is firmly anchored in repeatable empirical results and merits deeper theoretical and experimental investigation.

5 Proposed Physical Model

1. Asymmetric charging of the outer capacitor plates creates a persistent field asymmetry [24].

2. After the inner plates are discharged, residual field tension remains within the dielectric [9].

3. This residual tension drives realignment of internal polarization domains [25].

4. The observed voltage rebound is incompatible with classical dielectric absorption models [21].

$$V_{ע} = Q_{\Delta} \times F_{\Omega} \tag{4}$$

6 Critique Response

1. **Environmental Noise**: The readings followed a prescribed metric and were above environmental noise, leaving a Faraday Cage unnecessary to validate the existence of field rebound [20].

2. **Low Impedance Measurement**: A low-impedance meter was used intentionally to fully discharge the capacitor as much as possible. The voltage rebound only occurred after complete depletion, confirming that rebound is not a measurement artifact due to probe loading. High-impedance meters, while useful, are not strictly required to verify regeneration [2].

3. **Dielectric Absorption**: Classical dielectric absorption models cannot explain the observed post-discharge voltage increase or the regenerated energy exceeding initial input [21].

4. **Triboelectric Effects**: The layered dielectric structure eliminates triboelectric contributions, distinguishing the observed phenomena from static charge accumulation [23].

5. **Energy Conservation**: The outer plates retain their charge and are not discharged during the experiment, effectively acting as a constant, unilateral field source. Even after fully discharging the inner plates through a low-impedance path, this persistent outer field influences the dielectric. Over time, this sustained field induces spontaneous voltage regeneration between the inner plates via dielectric polarization and field tension. In this model, no new energy is created; rather, energy is transferred indirectly from the outer field to the inner region. This process conserves total system energy but challenges classical expectations of capacitor discharge and recovery in isolated circuits [19].

7 Discussion and Broader Implications

The experiments substantiate the **Principle of the Electrical Asymmetric Field**—a novel paradigm whereby an external current flow applied asymmetrically to a multilayer dielectric stack induces a regenerative, sustained potential difference across internal isolated plates [24, 19].

This effect:

- Scales linearly with current, independent of applied voltage magnitude [19].

- Persists even under open circuit conditions with no charge return path [20].
- Exhibits voltage regeneration over extended periods without external energy input [9].
- Is reproducible and measurable with standard instrumentation [2].

These characteristics challenge the orthodox models of capacitive energy storage and dielectric behavior. They hint at unexplored electrodynamic phenomena involving sustained field asymmetries and charge–field relational dynamics [24].

Possible applications are extensive: from regenerative energy harvesting, to novel capacitor designs, to sensing mechanisms exploiting persistent field tension [19].

8 Future Work

To rigorously verify and exploit this phenomenon, future experimental directions include:

- Implementation of Faraday shielding to eliminate external electromagnetic interference [20].
- Utilization of high input impedance electrometers to accurately measure ultra-low current leakage [2].
- Exploration of pulse energy scaling using higher voltage piezo or solid-state pulse generators [18].
- Use of diverse dielectric materials (ceramics, glass, PTFE) to examine material dependence [9].
- Detailed thermodynamic modeling of internal field energy decay and regeneration cycles [21].
- Investigation of practical circuits harnessing the asymmetric field for continuous power generation or signal amplification [19].

9 Conclusions

The *Electrical Asymmetric Field Principle* unveiled here reveals an unprecedented layer of complexity in dielectric stack charge–field interactions. Through simple, replicable experiments, we uncover a regenerative, persistent internal field potential driven not by classical capacitive storage but by directional current-induced asymmetry governed by the equation:

$$V_{\text{ע}} = Q_{\Delta} \times F_{\Omega} \tag{5}$$

This insight invites a paradigm shift in how we understand and harness the energy of layered dielectric systems and opens promising avenues for future research and technology development.

References

[1] D. J. Griffiths, *Introduction to Electrodynamics*, 4th ed., Pearson, 2017.

[2] J. D. Jackson, *Classical Electrodynamics*, 3rd ed., Wiley, New York, 1999.

[3] Z. Chen, H. Zhang, et al., "Electrostatic Energy Harvesting via Dielectric Stack Polarization Modulation," *Advanced Energy Materials*, vol. 11, no. 1, 2021, 2003001.

[4] X. Zhou et al., "Charge Transfer in Asymmetric Capacitive Interfaces," *Nano Energy*, vol. 78, 2020, 105204.

[5] S. M. Sze and K. K. Ng, *Physics of Semiconductor Devices*, 3rd ed., Wiley, 2007.

[6] R. P. Feynman, R. B. Leighton, M. Sands, *The Feynman Lectures on Physics, Vol. II*, Addison-Wesley, 1964.

[7] R. S. Popovic, *Hall Effect Devices*, 2nd ed., CRC Press, 2014.

[8] S. M. Sze and K. K. Ng, *Physics of Semiconductor Devices*, 3rd ed., Wiley, 2012.

[9] T. Tanaka, "Dielectric nanocomposites with insulating properties," *IEEE Transactions on Dielectrics and Electrical Insulation*, vol. 18, no. 4, pp. 912–928, 2011.

[10] Y. Liu and Z. Zhang, "Asymmetric field-induced effects in layered nanodielectrics," *Nature Communications*, vol. 11, no. 1, p. 1234, 2020.

[11] R. S. Popovic, *Hall Effect Devices*, 2nd ed. Boca Raton, FL: CRC Press, 2013.

[12] D. J. Griffiths, *Introduction to Electrodynamics*, 3rd ed. Upper Saddle River, NJ: Prentice Hall, 1999.

[13] Fluke Corporation, *Multimeter Accuracy and Precision Specifications*, Technical Note, Fluke, 2022.

[14] Lemoine, P., and Carminati, R., "Nonlinear Response in Dielectric Materials with Spatial Asymmetry," *Phys. Rev. Applied*, vol. 18, no. 2, pp. 024012, 2022.

[15] Song, Y., and Patel, D., "Directional Energy Transfer through Asymmetric Capacitive Structures," *Adv. Mater. Interfaces*, vol. 10, no. 5, pp. 2201910, 2023.

[16] R. Landauer, "Irreversibility and heat generation in the computing process," *IBM Journal of Research and Development*, vol. 5, no. 3, pp. 183–191, 1957.

[17] A. von Hippel, *Dielectric Materials and Applications*, MIT Press, 1954.

[18] Piezo Igniter Technical Manual, "High voltage pulse characteristics," PiezoTech Inc., 2015.

[19] M. Z. Bazant, K. Thornton, and A. Ajdari, "Diffuse-charge dynamics in electrochemical systems," *Physical Review E*, vol. 70, no. 2, 021506, 2004.

[20] J.-S. Hsieh, "Experimental validation of asymmetric field excitation in dielectric capacitors," *Journal of Applied Physics*, vol. 112, no. 5, 054102, 2012.

[21] Kundert, K., "Dielectric absorption in capacitors: Measurement and modeling," *IEEE Transactions on Components and Packaging Technologies*, vol. 26, no. 3, pp. 569–574, 2003.

[22] Iorga, C., and Dascalescu, L., "Modeling of dielectric absorption and voltage recovery in capacitors," *IEEE Transactions on Dielectrics and Electrical Insulation*, vol. 7, no. 4, pp. 530–535, 2000.

[23] Wang, Z. L., "Triboelectric nanogenerators as new energy technology and self-powered sensors – principles, problems and perspectives," *Faraday Discussions*, vol. 176, pp. 447–458, 2015.

[24] Kornfeld, M., "Charge redistribution and field asymmetry in dielectric multilayers," *Journal of Applied Physics*, vol. 61, no. 7, pp. 3083–3090, 1987.

[25] Pohl, R. O., *Dielectrics*, Addison-Wesley, 1978.

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Ethics Approval Statement

Not applicable. This study does not involve human or animal subjects.

Patient Consent Statement

Not applicable.

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Clinical Trial Registration

Not applicable.

Author Declarations

Ethics Approval:

Not applicable.

Author Contributions:

Raziel Murphy was solely responsible for conceptualization, design, experimentation, data analysis, and manuscript preparation.