

The Effects of Radiation-Induced Defects on The Electrostatic Discharge of polymers

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INTRODUCTION

- Test were done to see how radiation-induced defect states affect the electrostatic discharge (ESD) breakdown potential of a material.
- Electrostatic discharge is the one of the most common reason for space craft failures.

HOPPING CONDUCTIVITY

Defect states

Visualization 2-D lattice defect states

Symmetry of movement in lattice

Thermally assisted hopping conductivity



APPLYING A VOLTAGE

Creates electrically assisted hopping conductivity

Makes current flow in one direction

Energy of electron is equal to dE_q

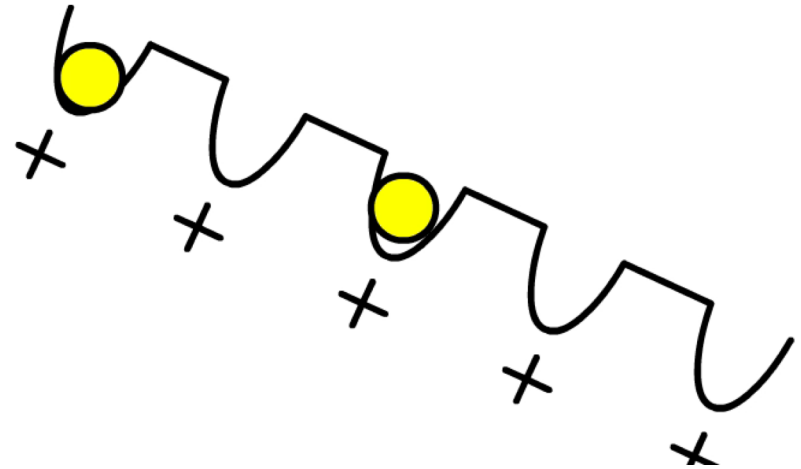


INDUCING BREAKDOWN

Creates electrically assisted hopping conductivity

Makes current flow in one direction

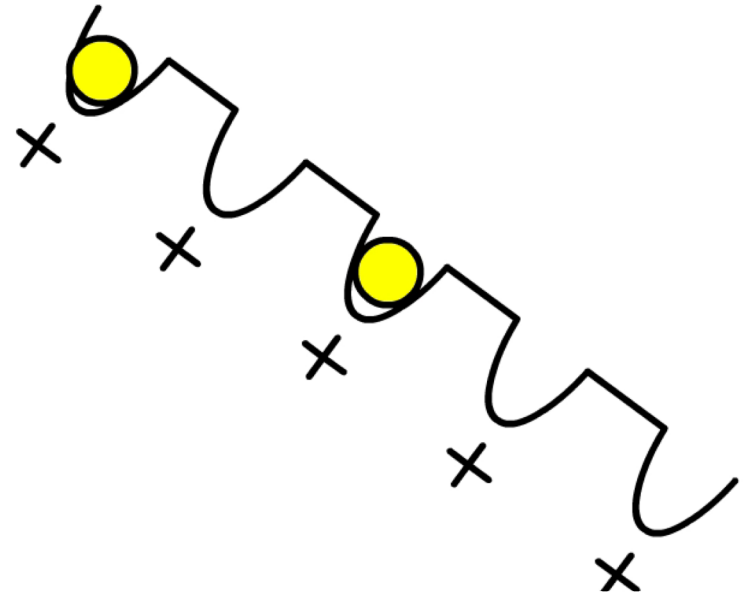
Energy of electron is equal to dEq



INDUCING BREAKDOWN

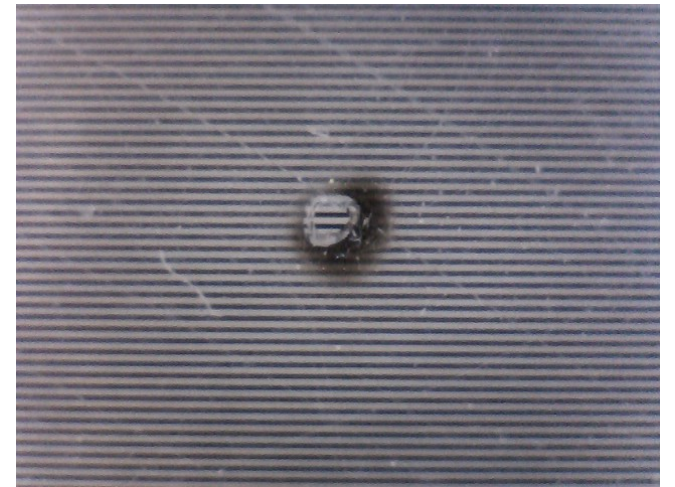
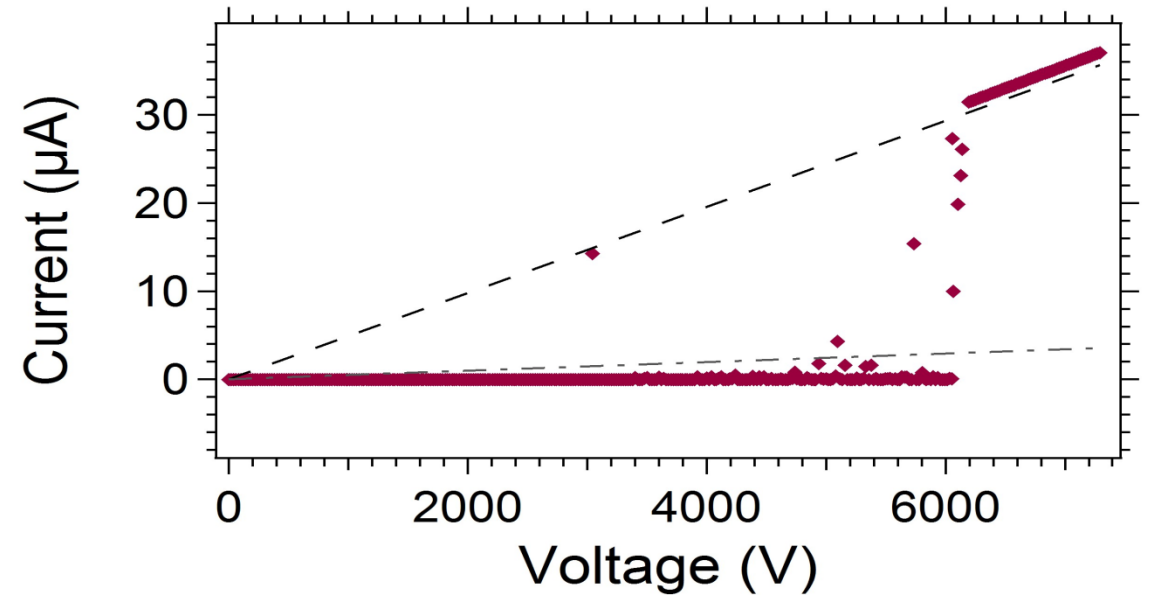
ESD is seen as an extreme limit of conductivity

ESD occurs when electrons have enough energy to excite other electrons and freeing more and more electrons



BREAKDOWN

- ESD is determined when an ohmic slope is observed and is set by the current limiting resistors.

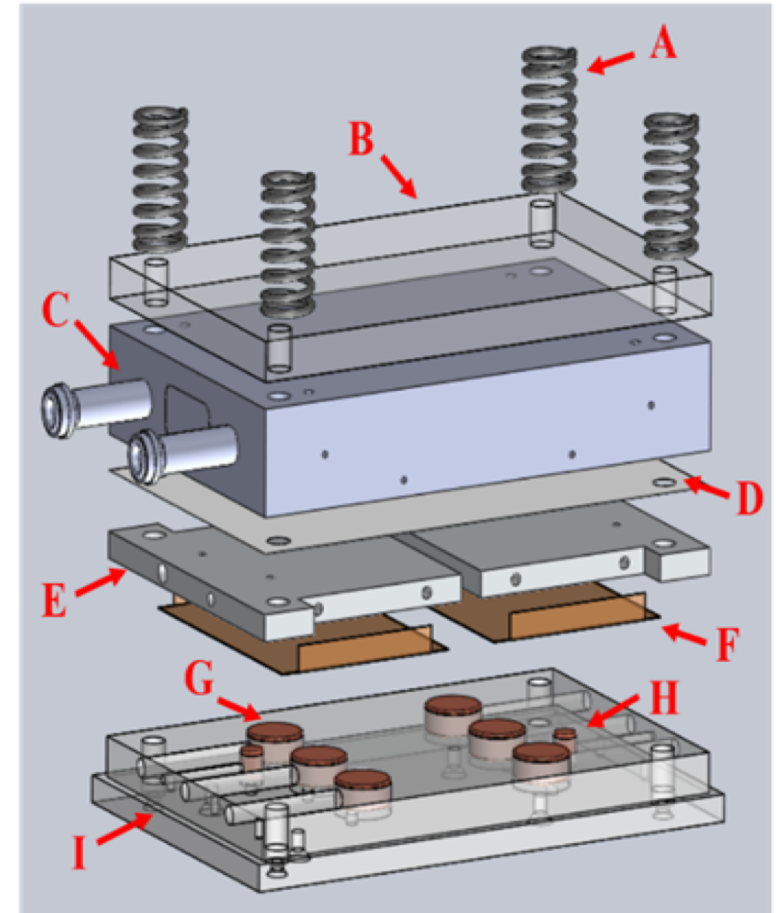


Beta Radiation

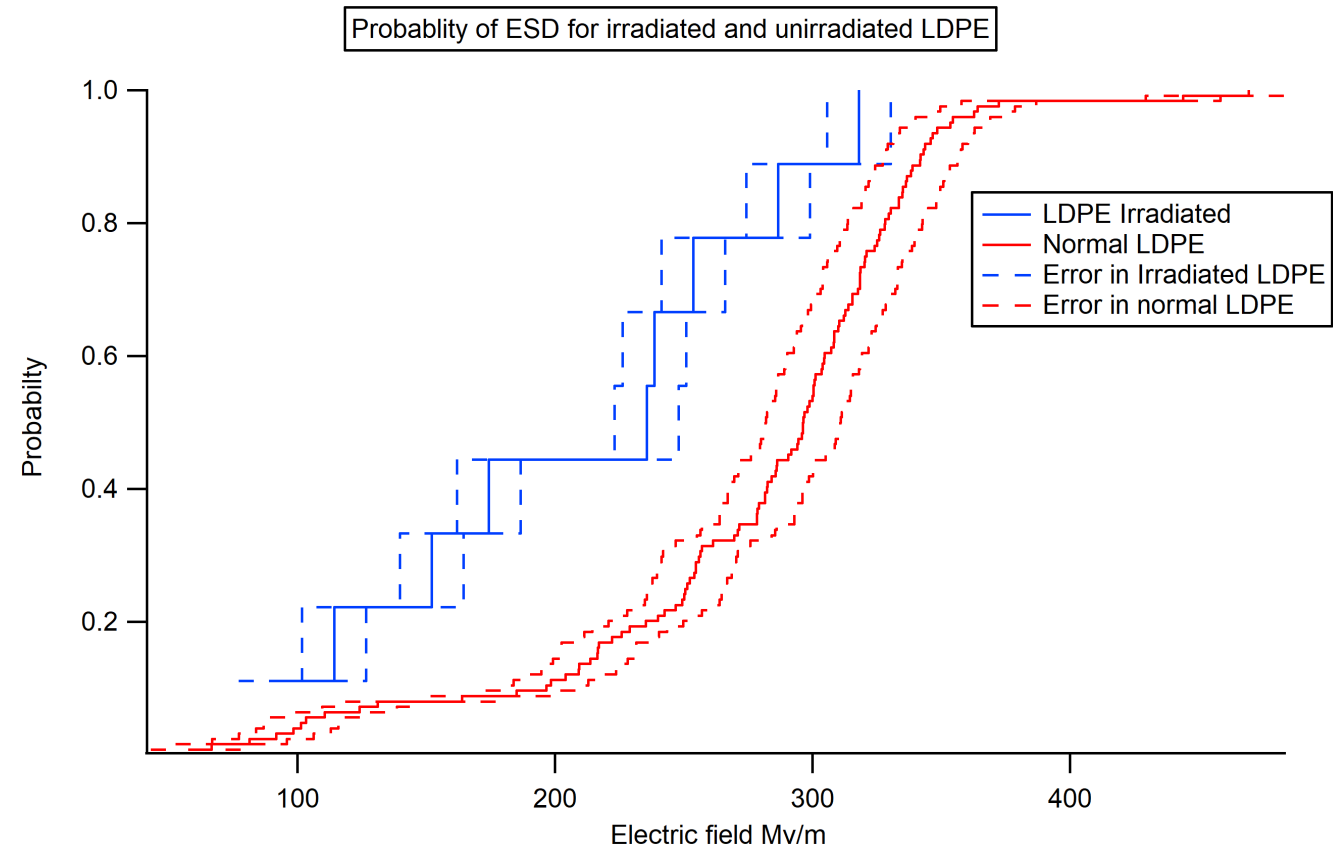
- Known to cause more defect states
- Defects are normally more shallow
- Less energy needed of ESD

Method

- Backed out samples to remove moisture
- Exposed samples to 5KGy of radiation in vacuum using a strontium-90 source creating more localized defects
- Ran test in ESD chamber which is set up in a parallel plate geometry voltage steps up at rate of 20 volts every 4 seconds until break down
- The thickness of the sample is then measured and used to calculate the electric field strength at breakdown
- ESD Assembly **A.** adjustable pressure springs **B.** insulating layer **C.** cryogen reservoir **D.** thermally conductive, electrically isolating layer **E.** sample and mounting plate **F.** sample **G.**



RESULTS



CONCLUSION

- Found LDPE that has been exposed to radiation is more likely to have ESD to occur at lower electric fields than standard LDPE.
- Tests need to be performed on other polymers that have different tolerances to radiation