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Electrons in Duane-Hunt Law and Drift in Semiconductors

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ABSTRACT : *This communication compares thee electric fields during X-ray production in a vacuum tube and during drift of electrons at high electric fields and at velocity saturation in silicon as a semiconductor The electric fields in the semiconductors are found to be comparable , or rather larger in silicon.*

KEYWORDS - *Semiconductors, Silicon, Vacuum, Scattering, Laws.*

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I.INTRODUCTION

In this short communication, the electric fields for electrons are compared during X-ray production by the Duane-Hunt Law [1] in vacuum and during drift of electros in silicon semiconductor as an example semiconductor. The method of questioning to Google in the AI mode is adopted and the answer received is presented in the form of a TABLE.

II.METHOD

Interaction on Google in the AI mode is performed by asking questions and acknowledging the answers. Here, Google was asked to compare the electric field for the electrons in the Duane-Hunt X-ray production and in the drifting electrons in Silicon as an example semiconductor reaching velocity saturation and "hot electrons" having 0.6eV energies and to give the electric fields in KV/cm. The answer was provided in a TABLE form as presented below:

Table Comparison of Electric fields during X-ray production and drift of electrons in Silicon

Physical Scenario	Typical Electric Field (\(E\))	Physical Context & Significance
Duane-Hunt X-Ray Production	30 to 200 kV/cm	Macroscopic vacuum field. High accelerating voltages (e.g., 50–150 kV) are applied across a centimeter-scale gap (vacuum) to give electrons massive kinetic energies before impacting a metal target.
Silicon Velocity Saturation	10 to 50 kV/cm	Microscopic semiconductor field. At this field strength, electrons drift fast enough that they frequently collide with the crystal lattice (optical phonon scattering), causing their drift velocity to plateau at roughly \(10^7 \text{ cm/s}\).
Silicon "Hot Electrons" (0.6 eV)	100 to 300 kV/cm	High-energy semiconductor regime. The electric field is strong enough to push the average electron energy well above the room-temperature thermal energy (KT=0.026 eV) up to 0.6eV, approaching the threshold for impact ionization.

The main difference between the electrons during drift and Duane's X-ray production is that Duane's experiment needs vacuum through which electrons are accelerated from the cathode to the anode, whereas there is scattering during drift of electrons in semiconductors at high fields such as in Silicon. My work deals with the

drift of electrons in semiconductors such as Silicon. We are both using electrons. Duane produces X-rays using the Duane-Hunt law that gives the formula for minimum photon wavelength = eV/h [1], where h is Planck's constant. In my work, I find the energy levels like the intrinsic Fermi level and the pinned Fermi level in the bandgap of a semiconductor using the equation dE/E = dm/m [2], which is the differential form of Einstein's mass-energy equivalence relation $E= mc^2$. Nowadays, AC (microwaves) is used to accelerate the electrons towards the anode. Duane had used high-voltage DC. The X-rays produced are used for cancer treatment.

III.CONCLUSION

Surprisingly, the microscopic electric fields inside nanoscale silicon transistors operating under high bias (100–300 kV/cm) are equal to or greater than the macroscopic electric fields used inside massive industrial X-ray tubes (30–200 kV/cm). This intense internal field is why modern sub-micron semiconductor design requires careful management of hot-carrier degradation.

REFERENCES

[1] Google, Wikipedia, Duane-Hunt Law.

[2] R.K. Chanana, The Unified Law for Particles and Waves in Materials, *Applied Sciences Research Periodicals*, *4(2), 2026*, 43-44.