Parametric interactions in Ion Implanted semiconductor Plasmas

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- The physics of solid state plasma is now a well established scientific discipline born form the discovery of an overlap between the realms of solid state physics and plasma physics.
- Due to dilute nature of semiconductors, amongst all solid-state plasmas they are found to be more appropriate materials in which one can obtain both types of plasmas.
- This field has developed into one of the fastest growing area of science in the last decade.

- The formation of plasma crystal and the existence of waves and instability in complex plasma are two fundamental physical interest receiving areas of studies.
- In case of solids among many processing techniques, ion implantation and the very recent one plasma source ion implantation (PSII) or plasma immersion ion implantation (PIII) has proved to be very promising and is used for almost all kinds of doping in semiconductor material in low energy and high dose regime.
- Ion implantation is a material engineering process by which ions of a material can be implanted into another solid hereby changing the physical/structural or chemical properties of solid.

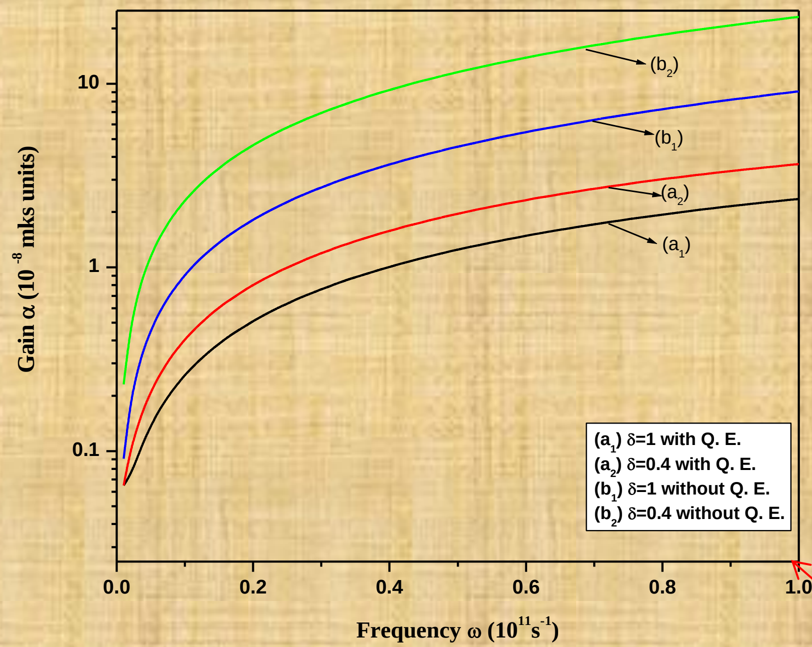
Hence become standard for this type of work due to its various advantages over the other techniques such as diffusion are:

- Large range of doses
- Extremely accurate dose control
- Wide choice of masking the target material
- Low processing temperature
- Short process time
- Good homogeneity etc.

- Ion implantation is a low temperature technique for implanting ions in the lattice of a semiconductor crystal in order to modify its electronic properties and it offers more flexibility than diffusion.
- As the ions enter the crystal lattice, collide with the host atoms, lose energy, and finally come to rest at certain depth within the solid. These implanted metal ions are neutralized during the retardation process and somehow agglomerate to form colloids.
- Ions gradually lose their energy as they travel through the solid ; the lose of ion energy in the target is called Stopping.
  - *Stopping of the implanted ion is dominated by nuclear collisions at low energy implants, while*
  - *Electronic Stopping is dominant for high energy implants.*

- The reason behind such a study is that in semiconductors, the charge carriers (electrons and holes) have high number densities and comparable masses.
- Therefore, it is expected that low as well as high frequency perturbation can be excited and modified in presence of colloids when they are participating in wave interaction phenomena.

- It appears from the available literature that in most of the previous reported works in field of parametric excitation of acoustic waves in quantum plasma SDDC effect has not taken into account.
- Thus, motivated by the above we have focused our attention on the modifications occurred by including the SDDC effect and we have analytically investigated the quantum effect on parametric process in material with high dielectric constant.
- The process is characterized by the effective third order susceptibility induced due to nonlinear current density in the high dielectric constant semiconductor plasma medium.



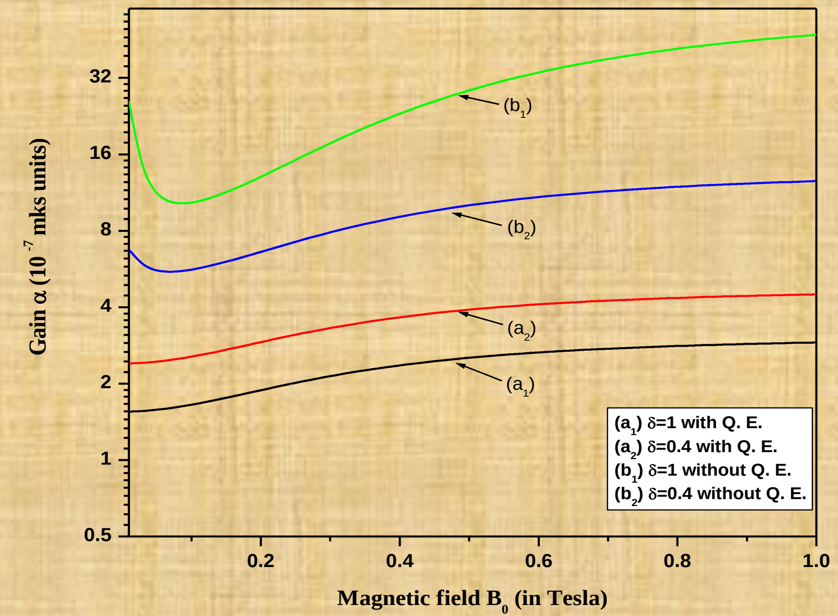


***Figure 3:** Variation of acoustic gain with magnetic field*

***Figure 1:** Variation of acoustic gain with wave frequency*

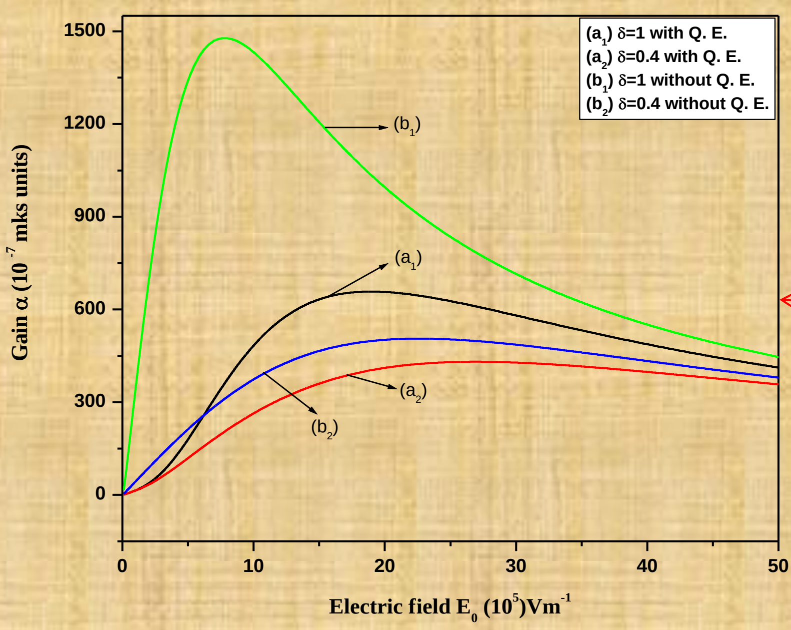


***Figure 2:** Variation of acoustic gain with electric field*

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Conclusion

- In order to study the parametric interaction in high dielectric constant material using QHD model the third susceptibility has been derived.
- The quantum effect on characteristics of third order susceptibility has been investigated. In presence of quantum correction terms it is found that all characteristics get modifies.
- The susceptibility profile is also similar to the dispersion characteristics of III-V group semiconductors. From the above referred work we conclude that the fundamental study of parametric process in material with high dielectric constant is important and effective tool for the fabrication of parametric amplifiers.