GaN quantum dots:

All-optical single-electron read-out Devices

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What is single electronics ?

- Coulomb energy vs thermal energy
- Single electron memories, multibillion dollar business
- Some “less promising” applications

Coulomb Energy

- $E_c = e^2/2C$
- Confinement energy

$$E_p = h^2/2ml^2$$

- Thermal fluctuation $kT << E_c + E_p$

Money plays a role

Some other applications

- Devices for precise current & capacitance measurement
- Electrometers
- Single electron temperature sensors

Now, GaN quantum dots!!!

- Fabrication processes
- Can we see the dots?
- Built in electric field
- Dipole-dipole coupling
- I still don’t understand

GaN/AlN

Lattice mismatch ~2-3%

MOVCD growth

MBE growth

QD Density $10^{11}/cm^{-2}$

Temperature ~ 700-1100C

Dot size & density controllable

Built in field

- Piezoelectric field
- Spontaneous field
- Electric field is up to MV/cm
- Band bending

Potential well

- Parabolic potential

$$H = \sum_{\alpha = e,h} [H^0_{z\alpha} + m_\alpha \omega^2_\alpha (x^2_\alpha + y^2_\alpha)/2] - e^2/\epsilon |\mathbf{r}_e - \mathbf{r}_h|$$

- Energy levels

Read & write

- Energy shift ~ 10meV
- Readable with current technologies
- Laser probe
- Long range interaction
- Quantum computing

Some comments

- Building block doesn’t mean a building
- Quantum perturbation
- Thermal effect
- Tunneling between dots

Conclusion

- Thank you