

Epitaxial Growth GaAs on Silicon

Why?

Large area wafers not available with GaAs
GaAs expensive

(Possibly Si GaAs integration, GaAs for opto - or speed, Si for computing power)



Ravi Droopad displays a 12-in. GaAs-on-silicon wafer. (Motorola)

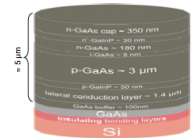
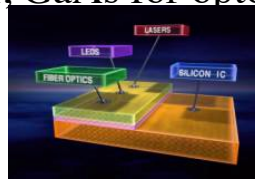


Fig. 4: Schematic of the thick solar cell structure grown on the water-bonded GaAs/Si-substrate.



Some Materials Science Problems

Antiphase boundaries

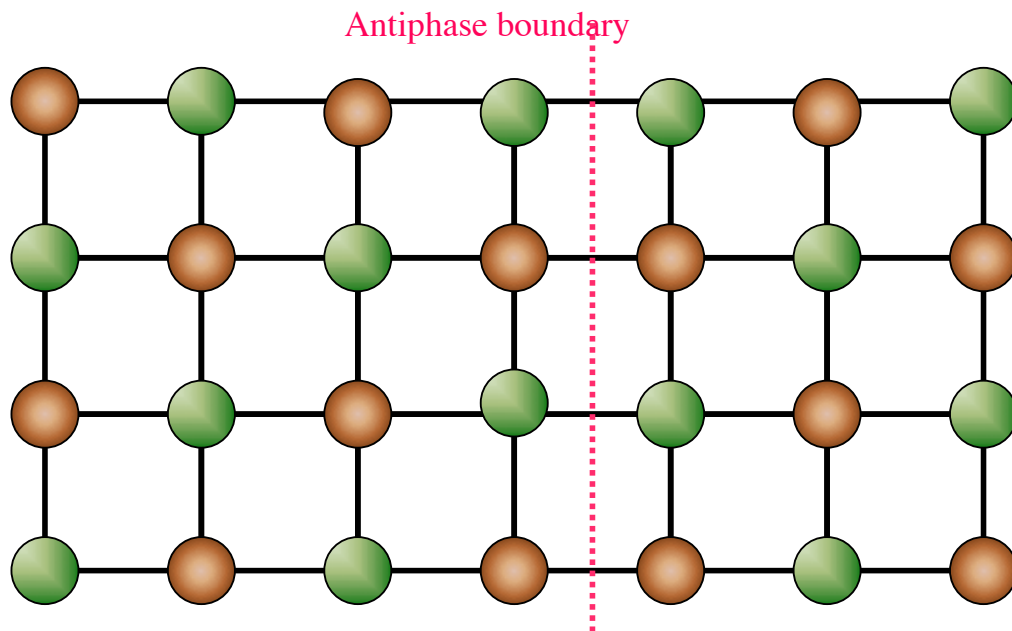
GaAs/Si interphase electrically charged

Autodoping

Lattice mismatch

SiO₂ surface

What are antiphases?

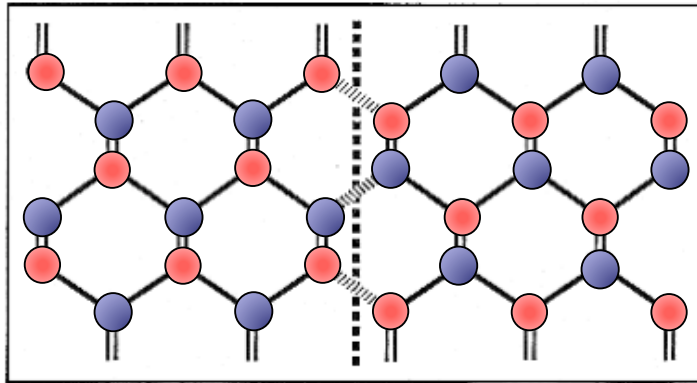


Why do they naturally occur in GaAs
when grown on Si?

Why are they
harmful?

Antiphases: Why harmful

GaAs antiphase
domain
(two fcc)



Ga-As bond neutral $\frac{3}{4} + \frac{5}{4}$ el pr bond = 2

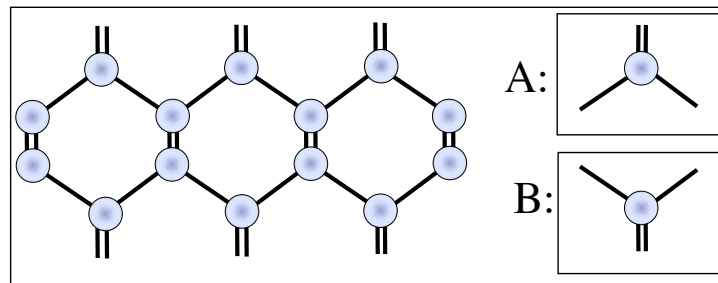
Ga-Ga bonds neutral $\frac{3}{4} + \frac{3}{4}$, paired bond 2, accept $\frac{1}{2}$ el

As-As bonds donors gives off $\frac{1}{2}$ electronic charge

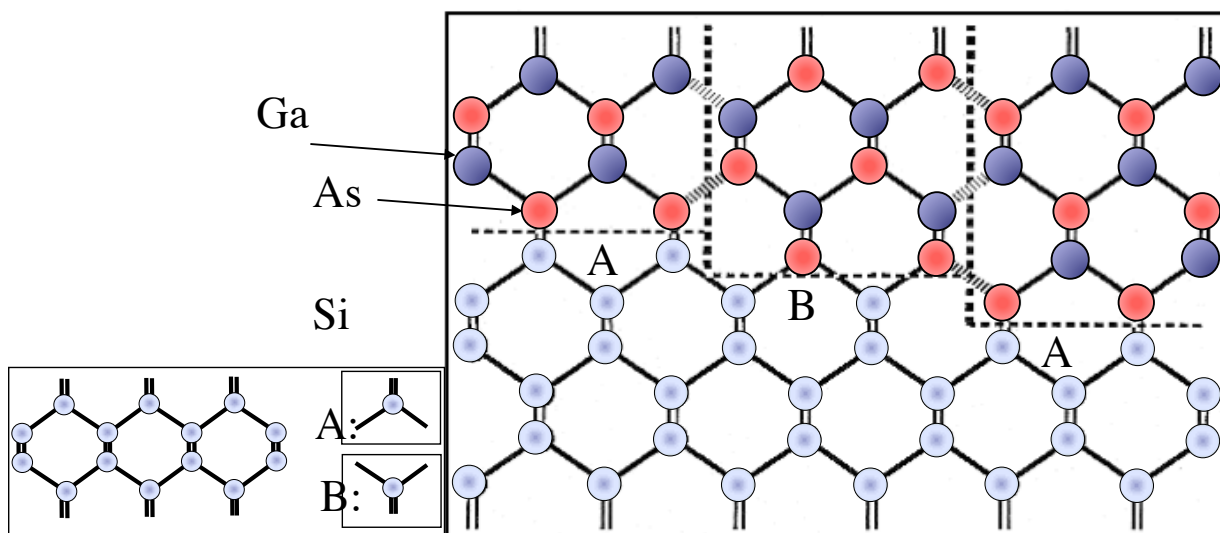
Scattering of electrons, lower mobility (harmful for FET)
recombination centers harmful for optoelectronic devices

Antiphases: Why natural on Si?

Si -two sublattices
(two fcc)

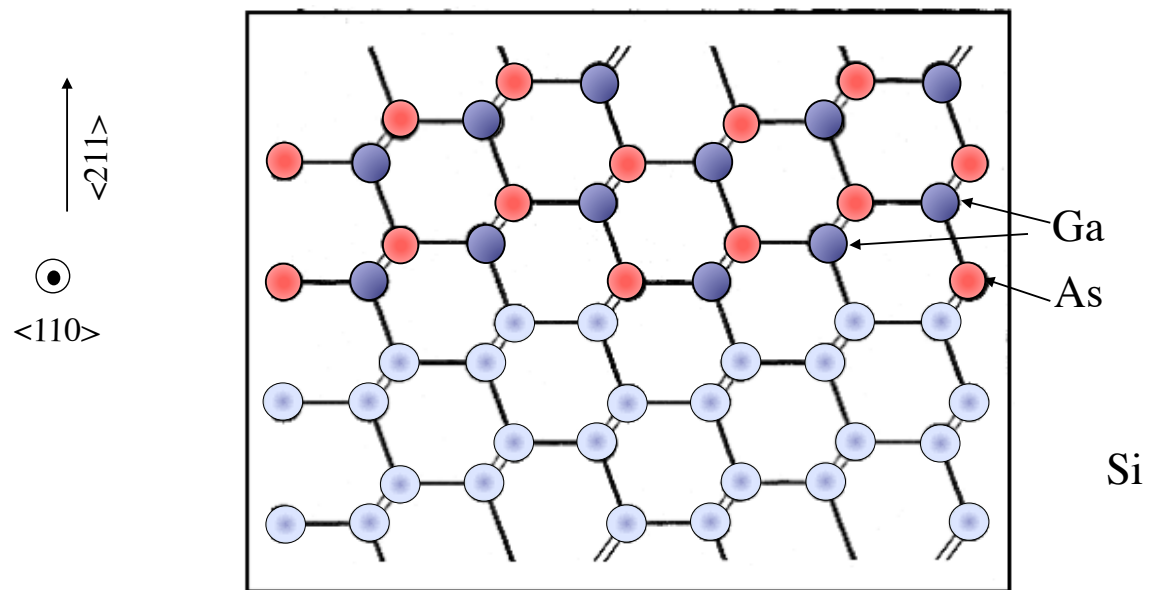


Antiphases: Why natural on Si? 2

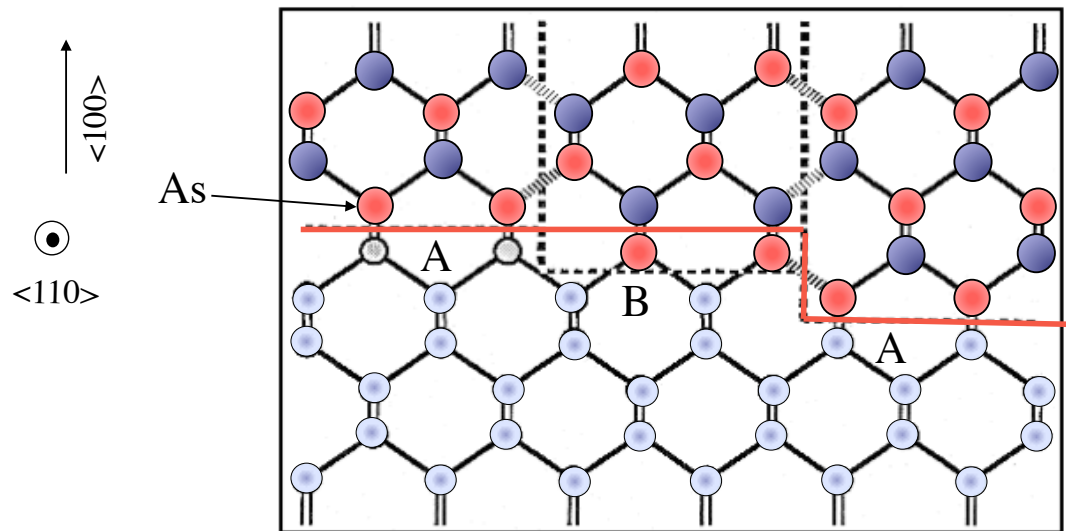


The (211) surface

No Antiphases:



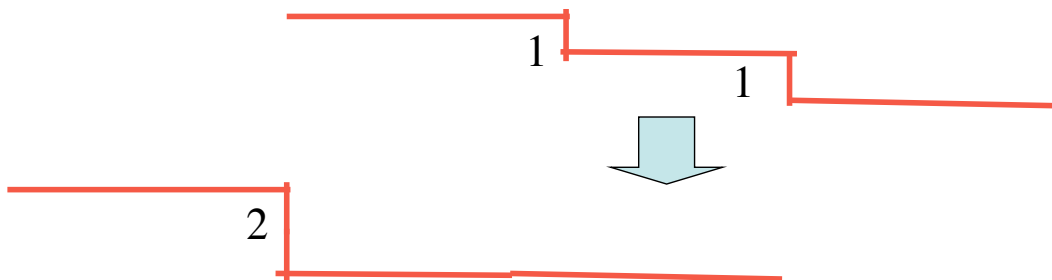
Back to (100) surface, single step vs dbl step



So if only had double steps - then fine

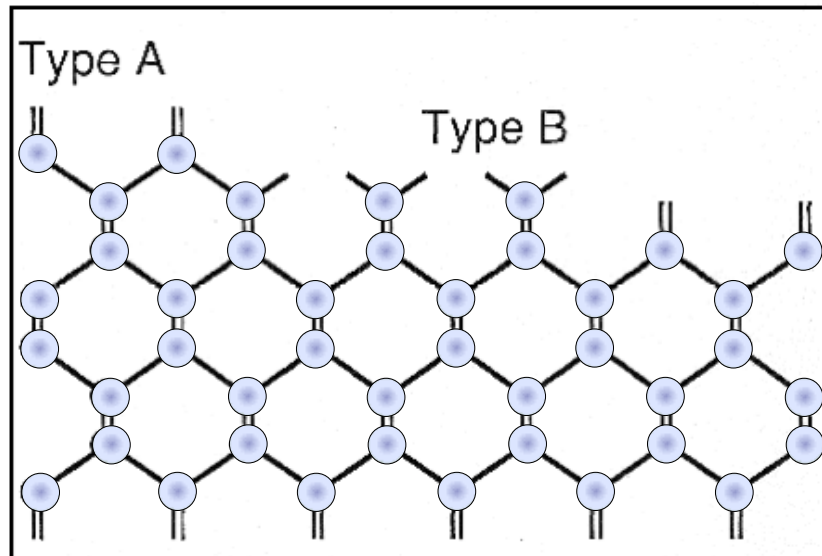
Back to (100) surface, single step vs dbl step 2

Single steps



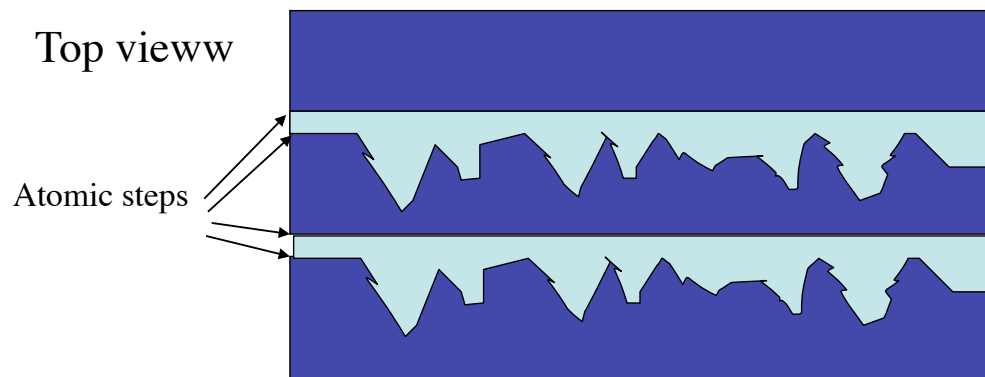
Is it possible to make only double steps ?

Back to (100) surface, single step vs dbl step 3



Type A lower energy than B,
It IS possible to make only steps typ A

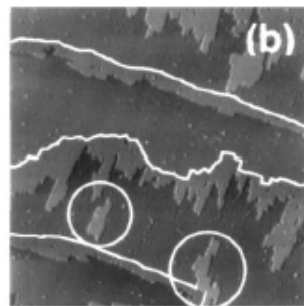
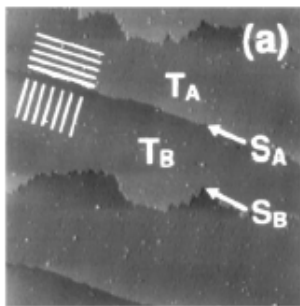
Back to (100) surface, single step vs dbl step 4



Type A lower energy than B,
It is possible to make only steps typ A

Back to (100) surface, single step vs dbl step 5

STM *Scanning tunneling micrographs)



Type A lower energy than B,
It is possible to make only steps typ A