COMHEAT
Microwave AB

A new latch-free LIGBT on SOI or bulk

Lars Vestling and Klas-Håkan Eklund

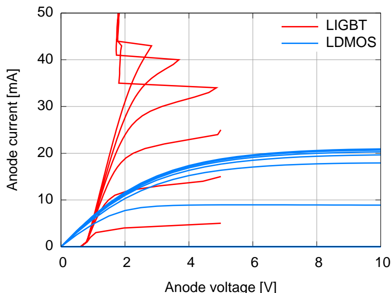
ComHeat Microwave AB
Uppsala, Sweden

2014-03-12

ComHeat Microwave AB is a member of the GigaHertz Centre, Chalmers, Göteborg, Sweden

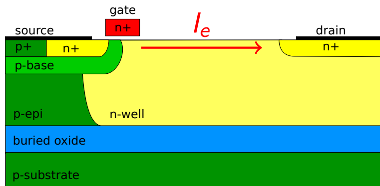
The LIGBT

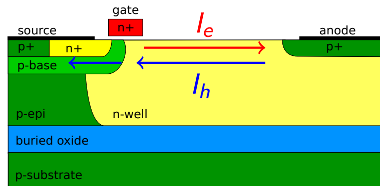
- Lateral Insulated Gate Bipolar Transistor
- An IGBT delivers lots of current due to a conductivity modulated drift region.
- A major problem is the latch-up that limits current and voltage.



LIGBT and Latch-up

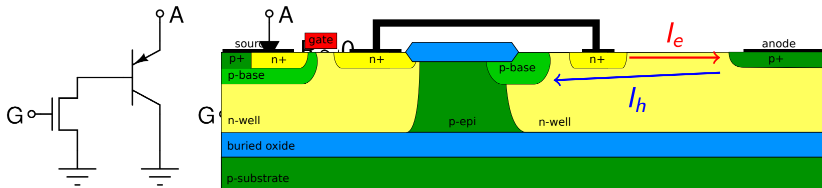
- Start with an LDMOS transistor.
- Replace the n+drain with a p+anode.
- Drift region is now a PNP transistor instead of a resistor.
- Hole current will increase the body potential and forward bias p-base to source and device gets shortcuted. Latch-up.
- Can be improved by e.g. lowering the p-base resistance or introduce a hole diverter.





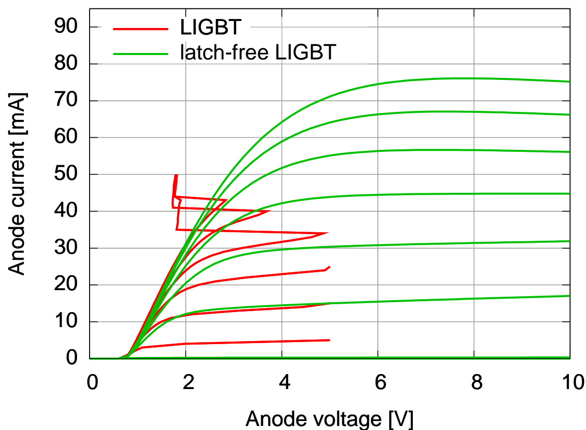
New concept

- The LIGBT can be represented by a MOSFET in series with a PNP transistor or a PIN diode.
- The MOS and the PNP are separated electrically/physically.
- Now the hole current has no chance to reach channel region and latch the device.



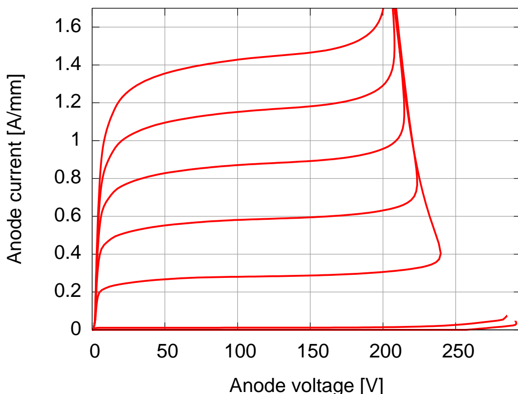
Results

- Measured IV-characteristics of a basic LIGBT
- Measured IV-characteristics of the latch-free LIGBT.



No latching

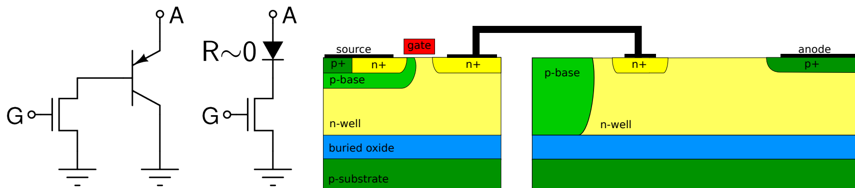
- Higher current and higher voltage.
- Faster device ($t_{off} \propto 1/I_{MAX}$)
- Implementing this device in a 200V SOI foundry technology.



Simulation results

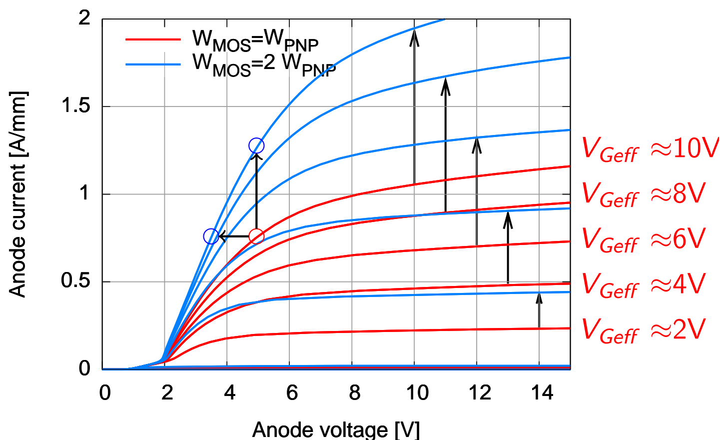
Opportunities

- The separation of the devices means that it can be done all the way, i.e. two separate devices.
- The width of the MOS and the width of the PNP (PIN diode) can now be choosen individually.
- The MOS generates the current. The PNP supports high voltage.
- On-resistance determined by MOS and not drift region length.



Example: MOSFET wider than PNP (drift region)

- $W_{MOS} = 2 \times W_{PNP}$



Measured results

- $I_{D,sat}$= 1-2 A/mm (base width).
  - state-of-the-art:
    - SOI-LIGBT (200V): 250 mA/mm
    - bulk Si-LDMOS (70V): 200 mA/mm,
    - GaN (70V): 1000 mA/mm
- Temperature coefficient is 3 times better than LDMOS ($< 350^\circ$)
- High frequency, $f_T \sim 3$ GHz and $f_{MAX} \sim 10$ GHz

Summary

- New uniq IGBT concept demostrated that totally eliminates latch-up.
- Drastically improved current capability (2A/mm) in a CMOS compatible technology.
- Separation of devices gives great flexability.
  - Input power reduction
  - On-resistance reduction
  - Compability with state-of-the-art CMOS (2V).

- Remark: the concept is not tied to any specific technology and can even be used on discrete IGBT devices.

Future work

- Manufacturing of 200V SOI devices will start March 2014
- VINNOVA project with Uppsala University and ComHeat Microwave started January 2014 and will study the RF properties of these devices.

Acknowledgements

- Chalmers for RF-measurements