Center for Energy Efficient Electronics Science
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Ultrafast Electrical Pulse Generation in Photoconductive Switches

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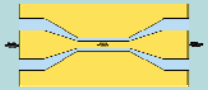
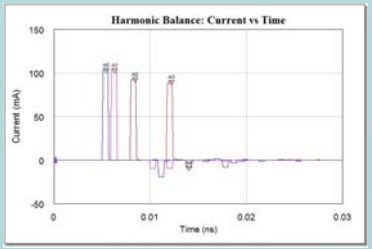
Abstract

Ultra-fast photoconductive switches (PCS) can be used to generate very fast electrical pulses. These pulses can be used to further examine the dynamics of magnetic switching. The project goal was to design and experimentally measure a photoconductive switch that exhibits sub picosecond electrical pulses and that can deliver a large current density to a load.

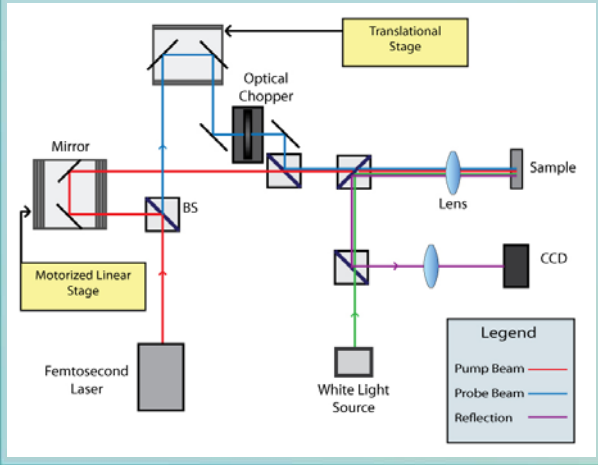
Simulation



- Transmission line modeled with AWP's Microwave Office
- Short voltage pulse was sent down the modeled transmission line
- Varied parameters
- Observed at multiple locations



Optical Setup

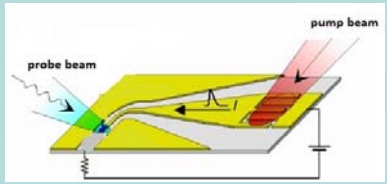


References

[1] Modified picture from "Research – Lawrence Berkeley National Laboratory", http://xraysweb.lbl.gov/peem2/webpage/Research.shtml

[2] http://www.batop.com/information/pictures/PCA_band_diagramme.png

Motivation



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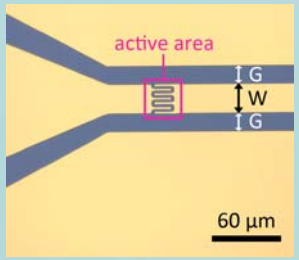
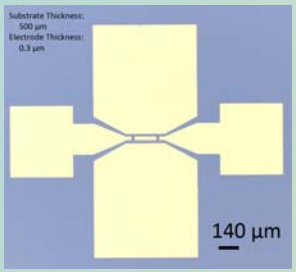
- Send ultrafast electrical pulses to magnetic load
- Achieve ultrafast magnetic switching

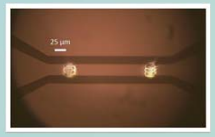
Design



- GaAs subtrate
- Gold electrodes
- Coplanar waveguide transmission line
- Active area utilized the multiple finger structure



- Gap to Width Ratio = 0.6
  - 50 Ohms impedance match

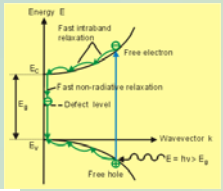


Discussion

- Project followed a three step process: simulating, fabricating, and experimental testing
- The R_on (resistance across the active area) impedance and the tapered region length were found to have minor effects on current density
- Simulations revealed high current density is possible with almost no broadening
- Currently unable to experimentally characterize the electrical signal in the device
  - Signal showed no peak point as path delays were varied
- First device showed a resistance lower than expected
- Saturation of carriers has not been reached
- Further testing is necessary

Low Temperature – GaAs (LT-GaAs)

- Has desired properties for PCS
- Defects in the band gap lead to fast non-radiative recombination
- Time interval < 1 ps



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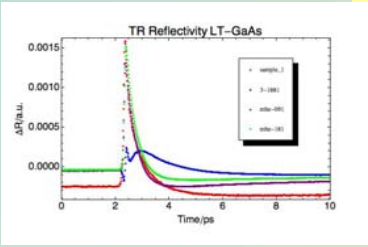
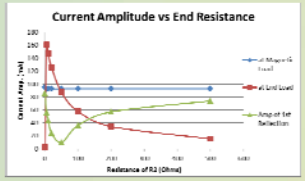
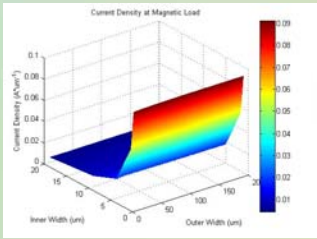


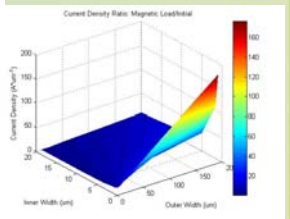
- High change in reflectivity shows generation of electron-hole pairs

Results

- Simulation results were found as expected
- Large outer transmission line width and small inner transmission line width can provide the desired result, a high current density







Acknowledgements

Yang Yang, Jeffrey Bokor,
UC Berkeley's EECS Department,
Center for Energy Efficient Electronics Science,
Nation Science Foundation

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Support Information
This work was funded by National Science Foundation
Award ECCS-0939514.