**Introduction**

- Terahertz (THz) radiation (light frequencies of 0.1 THz – 10 THz) has a variety of military, commercial, and academic applications.
- Photoconductive switches and photomixers can be used to generate THz radiation.
- Low-temperature-grown (LTG) GaAs and ErAs:GaAs have shown promise as photomixing materials due to their short carrier lifetimes (< 1 ps).
- Photoconductors are limited in output power by device failure at large bias voltages and intensities.
- Thermal breakdown of PC devices has not yet been well-studied due to high numerical and analytic complexity.
- COMSOL Multiphysics software was used to simulate a GaAs photoconductor under breakdown conditions to determine if thermal runaway is causing device breakdown.

**Computational Methods**

- Per the hypothesis, deep-level traps in GaAs photomixers may be causing an exponential temperature dependence on device carrier concentration.
- To test this, we included a temperature dependent electron concentration for above room temperature conditions:
  \[ \sigma = \sigma_0 e^{-\Delta E/kT} \]
- Optical absorption caused carrier generation in the photoconductor (based on Beer’s Law):
  \[ G(y) = \frac{\alpha I}{h\nu} e^{-\alpha y} \]
- Heat transfer equations, both Joule heating from dark current and photocurrent and optical heating from laser power:
  \[ \rho = k \nabla^2 T + J \cdot E + \alpha I e^{-\alpha y} \]
- Semiconductor transport equations were solved, with a Shockley-Read-Hall recombination term.

**Device and Model**

- Photograph of a 9x9 μm physical photomixer: "finger" electrodes visible in center of image.

**Results**

- The electric potential plot reveals the strong field between the interdigitated electrodes of alternating potential.
- Optical absorption caused carrier generation in the photoconductor (based on Beer’s Law).
- Heat transfer equations, both Joule heating from dark current and photocurrent and optical heating from laser power.
- Semiconductor transport equations were solved, with a Shockley-Read-Hall recombination term.

**Conclusion**

- These results support the hypothesis that device breakdown results from thermal runaway associated with exponential increase in carrier concentration.
- Numerical simulation reveals a strong qualitative agreement between COMSOL data and breakdown behavior observed in real devices.
- Future work: search for quantitative agreement between COMSOL Multiphysics simulations and experimental data.

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