Fabrication of SiC diaphragms for MEMS sensors using laser ablation

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MOTIVATION

- R&D of AlGaN/GaN membrane based MEMS pressure sensors for harsh environment;
- The proposed fabrication method needs bulk micromachining of SiC substrate;
- We present the requirements and results of fabrication of SiC diaphragms with epitaxial AlGaN/GaN heterostructures using femtosecond (FS) laser tools;
- The leaking of laser light can be minimized by maintaining a smooth pattern surface during the entire ablation process.

DESIGN & EXPERIMENTS

- Circular high electron mobility transistor (C-HEMT) as pressure sensing device is integrated on AlGaN/GaN membrane;
- For experiments, SPIRIT from HighQ Laser with 4W average power at 1040nm and 200kHz repetition rate at 350fs pulse length was used;
- Switch to the SH 520nm with 1.6W output power after the scanner (focal length 100mm) is available.

RESULTS WITH METALLIZATION

- Critical are the edges of the pattern as the scanning speed of the laser beam accelerates and focusing effects at corners cause damage;
- Back side damage can be reduced by adding the second harmonic to the 1040nm, further improve of quality by use of 520nm or shorter;
- The damage has its origin in several effects, some are:
  - Surface quality and scrupulous cleanliness of substrate
  - Polarisation of the laser light (Brewster effect, ripple formation)
  - Focusing and filamento effects at corners and microstructures

CONCLUSIONS

- Interdependent laser parameters can be optimized to suppress the back side damage only to a certain extent;
- Laser ablation in combination with RIE of SiC has the potential to fabricate new generation MEMS sensors for applications in harsh environment but further optimization of the processing technology is still needed;
- The leaking of laser light can be minimized by maintaining a smooth pattern surface during the entire ablation process;
- Back side damage was reduced when we suppressed ripple formation by perpetually rotating the direction of laser polarization, we shall investigate this in more detail

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