Color Centers Micromachining in 4H-SiC with Femtosecond Direct Laser Writing

R Cunha[1], K Tasso[1], M B Andrade[1,2], and C R Mendonça[1]

[1] *São Carlos Institute of Physics, University of São Paulo, São Carlos, Brazil*
[2] *Federal University of Ouro Preto, Ouro Preto, Brazil*
Contact Email: renansc90@gmail.com

Direct laser writing (DLW) is a well-established fabrication technique known for its ease of implementation, rapid prototyping, and relatively low cost. By using tightly focused ultrashort pulses on a material, femtosecond DLW enables micromachining through nonlinear optical effects, producing structures that facilitate the study of properties challenging to observe with other techniques. In this work, we explore the effects of femtosecond DLW on 4H silicon carbide (4H-SiC), a promising material for quantum photonics, sensing, and metrology. We studied the memory effect when different numbers of pulses interact with 4H-SiC. Our findings suggest that multiphoton interaction predominantly mediates the optical breakdown, with an incubation parameter of 0.045, a single pulse damage threshold fluence of $0.88\,\mathrm{J/cm^2}$, and a two-photon absorption cross-section of $4.3 \times 10^{-60}\,\mathrm{cm^4\,s/photon}$. Additionally, we investigated how the different threshold fluences affect the Raman and photoluminescence spectra of 4H-SiC. We observed the production of additional silicon phases and showed femtosecond DLW-induced color centers compatible with silicon vacancies.