High impact ionization rate in silicon by sub-picosecond THz electric field pulses (Conference Presentation)

Tarekegne, Abebe Tilahun; Iwaszczuk, Krzysztof; Hirori, Hideki; Tanaka, Koichiro; Jepsen, Peter Uhd

Published in:
Proceedings of SPIE

Link to article, DOI:
10.1117/12.2252058

Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

High impact ionization rate in silicon by sub-picosecond THz electric field pulses (Conference Presentation)

Abebe T. Tarekegne, Krzysztof Iwaszczuk, DTU Fotonik (Denmark); **Hideki Hirori,** Kyoto Univ. (Japan); **Koichiro Tanaka,** Institute for Integrated Cell-Material Sciences (Japan); **Peter U. Jepsen,** DTU Fotonik (Denmark)

ABSTRACT

Metallic antenna arrays fabricated on high resistivity silicon are used to localize and enhance the incident THz field resulting in high electric field pulses with peak electric field strength reaching several MV/cm on the silicon surface near the antenna tips. In such high electric field strengths high density of carriers are generated in silicon through impact ionization process. The high density of generated carriers induces a change of refractive index in silicon. By measuring the change of reflectivity of tightly focused 800 nm light, the local density of free carriers near the antenna tips is measured. Using the NIR probing technique, we observed that the density of carriers increases by over 8 orders of magnitude in a time duration of approximately 500 fs with an incident THz pulse of peak electric field strength 700 kV/cm. This shows that a single impact ionization process is happening in a time duration of less than 20 fs. The measurement is repeated by exciting the sample with an optical pump beam at a wavelength of 400 nm. The optical pump sets the initial free carrier density before the THz-induced impact ionization. The measurements show that the carrier generation mechanism depends on the initial free carrier density which confirms that the carrier generation mechanism is impact ionization, rather than the alternative carrier generation mechanism in high electric field, i.e. Zener tunneling. Finally this technique can be extended to investigate carrier dynamics in other semiconductors.

View presentation recording on the SPIE Digital Library:
http://dx.doi.org/10.1117/12.2252058.5391659175001

Ultrafast Phenomena and Nanophotonics XXI, edited by Markus Betz, Abdulhakem Y. Elezzabi,
Proc. of SPIE Vol. 10102, 101020Z · © 2017 SPIE · CCC code: 0277-786X/17/$18
doi: 10.1117/12.2252058