1550 nm Femtosecond Fiber Laser System for the Two-Photon Excitation of Transient Currents in Semiconductor Detectors

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The Two Photon Absorption - Transient Current Technique, TPA-TCT is a powerful tool for spatially resolved inspection of semiconductor detectors. The nonlinear absorption of light is excited by femtosecond lasers that deliver photons of energy lower than the band-gap energy of the semiconductor material. Simultaneous absorption of 2 photons (the sum of their energies being higher than the band-gap energy of the semiconductor) occurring only at the focal point of the laser, allows localized generation of transient current. For silicon, emission wavelengths longer than 1150 nm are required to fully avoid Single Photon Absorption, SPA.

The mode-locked Ti:Sa solid state laser is the current standard optical source of femtosecond pulses, but it operates with emission wavelengths in the 700 - 900 nm range. While complex, expensive and inefficient nonlinear frequency conversion techniques are used to extend Ti:Sa emission wavelengths to the near-infrared region, the natural emission wavelength of the erbium doped fiber laser is in the 1550 nm region, thus being an excellent candidate as exciting source of the TPA-TCT.

We have developed a femtosecond fiber laser system, of properties and functionalities particularly designed for the TPA-TCT. Based in an all-fiber Chirped Pulsed Amplification (CPA) architecture and seeded by a solitonic passively mode-locked erbium doped fiber oscillator, the system provides at its output femtosecond pulses at 1550 nm wavelength with configurable properties: pulse energy from <10 pJ to > 10 nJ, pulse repetition rate from single shot to 8 MHz and pulse duration from 200 fs to 500 fs. Standard deviation of the average output power in environmental conditions is below 1% (24 hours operation). Besides, the system offers the functionalities of emission-to-detection synchronization and of pulse properties characterization. Further work is envisaged to decrease the minimum pulse duration below 100 fs.