Ultra-fast method to create terahertz radiation advances materials science

May 24 2016, by Anneli Waara

Uppsala physicists have in an international collaboration developed a new method for creating laser pulses which are shorter, have much higher intensity and cover the THz frequency range better than current sources. The study is published today in the authoritative journal *Nature Photonics* and is of great importance to materials research.

"Many interesting, dynamic phenomena of interest to materials science occur within the so-called terahertz spectral range but it has been difficult so far to generate such short pulses," says Pablo Maldonado, one of the researchers behind the study.

The THz range has become increasingly important to science and engineering since so many dynamic processes such as molecular vibrations or magnetic spin waves usually vibrate with THz-frequencies. Therefore, there are many important areas of application for THz radiation such as medical diagnostics, security scanning at airports, molecular sensors or even wireless communications. However, it has been difficult to realise THz sources which cover the entire frequency domain and supply ultra-short pulses of sufficient intensity.

In collaboration with researchers from Germany, France and the USA, Uppsala University researchers Pablo Maldonado and Peter Oppeneer have developed a new THz laser emitter which has better properties than every such device so far made. It builds upon principles of ultra-fast spin transport developed by the Uppsala physicists.

Ultra-fast superdiffusion spin currents are generated by laser excitation in a nanometre thin metallic magnetic layer and move through the adjacent layer in less than a picosecond (10^{-12} seconds). There they induce the extremely short-lived charge currents which emit intensive THz radiation with a pulse width shorter than 0.5 picoseconds. In order to find the best THz emitter, the researchers from Mainz and Greifswald (Germany) synthesised more than 70 different thin metallic layer systems, which were measured in Berlin. The best emitter was found to consist of three different metal layers which together are less than six nanometres thick.

"It was pleasing that our theory of ultra-fast spin currents could be used in this way and that we can not only explain how spin currents are generated but also how they can be applied to create brilliant THz laser pulses," says Pablo Maldonado.

More information: Efficient metallic spintronic emitters of ultrabroadband terahertz radiation. *Nature Photonics*, DOI: 10.1038/nphoton.2016.91 , www.nature.com/nphoton/journal … nphoton.2016.91.html

Provided by Uppsala University