A step forward for ultrafast spintronics

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(Phys.org)—In spin based electronics the spin of the electron is used as a carrier of information. To meet the need for faster electronics, the speed must be increased as far as possible. Today, Uppsala physicists show in the magazine *Nature Communications* how spin information can be transmitted using spin currents at terahertz speeds – a thousand times faster than today.

In today's charge based electronics the electrons' charges are used to carry information. One downside to this technology is the significant energy loss that arises due to charging currents. If the electrons' spin is used as information carrier instead, it is possible to achieve much more energy efficient electronic components, which is the goal of the so called spintronics.

In order to realize the goal of spintronics, it is necessary to have controllable transport of spin magnetic moment in nanostructured materials. At the same time, spintronic operations must be performed as quickly as possible.

Three scientists at Uppsala University, Marco Battiato, Pablo Maldonado and Peter Oppeneer, together with physicists in Germany and the US, have shown how spin currents can be generated and transferred from one nano scale metal layer to another in less than a picosecond (10^{-12} seconds). Ultra-short light pulses (at femtosecond scale, 10^{-15} seconds) are used to create spin currents that move super-fast through the nanostructured layers and transfer the spin.

'Since the generated spin currents transport the spin magnetic moment in just a few femtoseconds, new technology is needed to detect them. We succeded to do so by using ultra-short x-ray flashes with a pulse length of just a few femtoseconds', says Peter Oppeneer, who leads the spintronic research at Uppsala University.

Spin magnetic moments were measured using magnetic x-ray spectroscopy which made it possible for the first time to see the spin dynamic processes that previously have been invisible. The Uppsala scientists developed a basic theory for these superdiffusive spin currents, which now have turned out to be the cause of ultra-fast spin dynamics.

'A distinguishing feature of super-fast spin currents is that they are caused by non-equilibrium processes, which is also the reason for their higher speed. With our discovery we have paved the way for future development of high-speed spintronics', says Peter Oppeneer.

More information: Ultrafast magnetization enhancement in metallic multilayers driven by superdiffusive spin current, Dennis Rudolf, Chan La-O-Vorakiat, Marco Battiato, Roman Adam, Justin M Shaw et al., *Nature Communications*, 2012.

Provided by Uppsala University