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ULTRAFAST DEMAGNETIZATION DYNAMICS BY TIME RESOLVED XMCD

Christine Boeglin
IPCMS, CNRS - University of Strasbourg, France

Ultrafast processes involving the electrons and spins are important issues for both fundamental science and for the potential applications in spintronics. Application of ultrashort infra-red laser pulses allows ultimately the manipulation of the local magnetization in magnetic films. In order to understand the change of the initial magnetic or structural state, induced by IR laser pulses, it is essential to describe the individual and fundamental processes taking place during the first hundred femtoseconds. Since the first observation of laser induced spin dynamics, the mechanisms responsible for the femtosecond demagnetization have been widely debated, but no consensus could be found until today. Time-resolved x-ray magnetic circular dichroism (XMCD) using synchrotron facilities and x-ray free electron sources have provided femtosecond time resolution and thus new information concerning femtosecond demagnetization dynamics. XMCD spectroscopy is an element-specific tool which can be used to study ultrafast magnetization, with chemical resolution. At soft x-ray energies it is now possible to measure the dynamics of the spin and orbital magnetic moments with temporal resolution of ~100 fs. Recent results using the potential of the XMCD technic, show that right after the IR laser excitation, interatomic transfer of angular moment takes place at the femtosecond scale, whereas the global demagnetization proceeds, illustrating one of the most efficient way of conservation of angular moment, during the loss of magnetization in the system. In recent works, it was shown that laser induced electron current activates sizable ultrafast dynamics too. Different theoretical approaches propose different microscopic models which are nowadays strongly debated. Our recent results show that such hot-electron current induced ultrafast dynamics produces two different characteristic times of demagnetization in rare earth 4f as well as in transition metal 3d elements in 4f-3d alloys. The results can be related to propagation times and velocities of the hot-electron pulses.

christine.boeglin@ipcms.unistra.fr