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Direct measurement of spin accumulation in the Cu layer due to spin currents from Co

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Spin transport is the key for reading or writing bits in spintronic devices by utilizing the Giant Magnetoresistance effect or the spin transfer torque effect. Spin currents have also been shown to play important role in the ultrafast manipulation of magnetization via all optical switching. Hence, detailed understanding of spin currents from ferromagnet to non-magnets is a crucial step in development of spintronic devices. However, directly observing these spin currents is extremely challenging due to magnetic moment injected into non-magnet being very small, less than 1/10000 of a regular ferromagnet. In this talk, I will present our recent measurements on the spin currents from a thin film Co ferromagnet into non-magnetic Cu metal in a nanopillar device. We have developed an extremely sensitive spectro-microscopy detection method based on element specific x-ray magnetic circular dichroism where current pulses driving the spin currents into the Cu layer are synchronized with the synchrotron x-ray photons. The sensitivity of this 'lock-in' technique has allowed us to detect the extremely small transient Cu magnetization. We observe two spin currents induced effects in the Cu layer. The first effect is the transiently induced magnetization which occurs in bulk of the Cu layer due to spin accumulation and has a magnitude of 0.00003 μB per atom. The second effect occurs at the Co/Cu interface where we observe a 10% increase or 0.004 μB per atom for the hybridized Cu atoms due to spin torque-alignment.