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Spin-current generation arising from mechanical motions[1]

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Spin current, the flow of spins, is a key concept in the field of spintronics.[2] To create and control spin currents, magnetic dynamics, electromagnetic fields, and thermal gradient have been used. Recently, the acoustically generated spin current was observed in an insulating ferromagnet.[3] However, the conversion between mechanical motions and the spin current in non-magnetic materials has not been studied so far. In this talk, we will present our recent results on spin-current generation from mechanical motions, including rigid and elastic motions in non-magnetic metals and semiconductors. In a rigidly accelerating body, the spin-orbit interaction (SOI) is modulated by the mechanical motion.[4] The augmented SOI leads to the spin-current generation from both mechanical rotation and vibration. On the other hand, in the presence of the surface acoustic wave (SAW), the elastically driven rotational motion of the lattice couples to electron spins and the spin current is generated in the direction of depth. Dependence of amplitude and frequency of the SAW, the spin diffusion length, and elastic parameters on the spin current will be shown. We will also discuss the enhancement of the SOI and the spin-rotation coupling caused by an interband mixing, using an extended k.p perturbation with the gauge potential due to mechanical rotation.[5]

[1]This work was done in collaboration with Jun'ichi Ieda, Kazuya Harii, Eiji Saitoh, and Sadamichi Maekawa.

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[3]K. Uchida et al., Nat. Mater. 10, 737 (2011).

[4]M. Matsuo, J. Ieda, E. Saitoh, and S. Maekawa, Phys. Rev. Lett 106, 076601 (2011); Appl. Phys. Lett. 98, 242501 (2011); Phys. Rev. B 84, 104410 (2011).

[5]M. Matsuo, J. Ieda, and S. Maekawa, arXiv:1211.0127.