

SPIN-ORBIT RECTIFIER FOR WEAK RF ENERGY HARVESTING

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PATENT STATUS

Country	Type	Number	Dated	Case
Patent Cooperation Treaty	Published Application	WO 2022/094107	05/05/2022	2021-041

Additional Patent Pending

BRIEF DESCRIPTION

The invention is a new rectifier/detector concept, simultaneously utilizing the Hall effect and spin-orbit torque. Both phenomena scales with the current density and improves inversely with the device cross-sectional area, providing the largest signals at the nanoscale. The invention injects RF current in a Hall material to generate a Hall voltage, and use the same RF current in a spin-orbit material to control a magnet, which then applies a magnetic field to the Hall material leading to a rectification of the Hall voltage. A magnet with low anisotropy energy is used to make it sensitive to low RF currents. The device and corresponding circuits in HSPICE use materials parameter for InAs as the Hall layer, Bi₂Se₃ as the spin-orbit (SO) layer, and a soft ferrite as the magnet, we calculate the DC voltage from a 200 nm thin device to be ~100 μV from a ~500 nW RF power. A series array of such devices that can improve the DC voltage to ~100 mV from the same RF power, while matching the receiver antenna impedance.

SUGGESTED USES

Scavenging of the ambient radio-frequency (RF) signals is of great current interest, especially in the context of internet of things, device miniaturization, and 3D integration, where integration of self-powered devices will be highly beneficial. The development of such technologies is severely limited by the conventional semiconductor rectifiers, especially for scavenging from the weak RF signals because of the thermal voltage limit, high resistance p-n junctions, etc. Most of the conventional technologies become highly inefficient when the input RF power is in the order of ~100 μW [2].

ADVANTAGES

The utilization of spin-orbit torque for rectification only yields an all-metallic structure but utilizes potentiometric spin voltage measurements which yield low efficiency. The proposed spin-orbit rectifier is able to produce $>10^5 \mu\text{V}/\mu\text{W}$ without any external bias and very high conversion efficiency ~ 70% even from RF power in the limit of 100 nW.

RELATED MATERIALS

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OTHER INFORMATION

KEYWORDS

radio, rectification

CATEGORIZED AS

» Energy

» Transmission

RELATED CASES

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