The directed electron transport in a spatially-periodic asymmetrical system — called “ratchet” — is under study. It is a system of two-dimensional electron gas (2DEG) formed in a semiconductor heterojunction and driven by an external linear-polarized microwave (MW) irradiation. The spatial inversion symmetry of the system is broken by introducing of artificial periodic array of asymmetric antidots shaped in semi-disc form. A dc voltage of few mV was observed in the “ratchet” antidot lattice under the MW irradiation. This effect was studied in two different materials with different antidot lattice parameters in function of magnetic field, temperature, MW polarization and power. The results are in good agreement with recent theory.

**Introduction**

Directed motion of a water droplet created by heating of the asymmetric metallic surface.

**Molecular Motors**

Perfected over the course of millions of years, the directed movement of molecular motors (Actin Myosin) use chemical energy (ATP) to make directed motion along a polymer filament (which is periodic and asymmetric).

**Examples**

Protein motor (Actin Myosin) sensitive to changes in the linear polarization of the microwave radiation in presented ratchet is it possible to change the direction of the transport. The polarization dependence is strongly dependent on electron-electron interaction strength.

**The Experiment**

Samples are high mobility 2DEG based on AlGaaS/GaAs heterostructures with Hall bar geometry. The lattices of semiconductor heterojunctions of significantly smaller than in previous samples of Si/SiGe. A square antidot array of 500 x 500 µm² (lattice parameters: period = 0.6 µm and radius = 0.2 µm). Lattices with the same parameters but with circular antidots were also fabricated.

**The Theory**

Exposed to the linear-polarised microwave irradiation, asymmetric antidot lattice (mososcopic periodical system of smaller than in previous samples of Si/SiGe) can play a role of quantum ratchet, while the MW itself will serve as driving force and as external energy input (which will drive the system out of equilibrium) at the same time. Directed electron motion induced by MW in such structures.

**Figure (a)** shows the magnetotransport measurements in one sample and a SEM image of a lattice. - Fig. (b) presents the photovoltage measurements: magnetic field dependence of the dc-voltage induced by the linear polarized microwaves in the ratchet antidot lattice, in a lattice of circular antidots, for two directions of polarization. The effect depends on MW polarization, it goes to zero in weak magnetic fields. - Fig. (c) shows temperature dependence of the ratchet signal and that of the mobility in ratchet part, intact 2DEG part and circular antidots part. The effect disappears at liquid nitrogen temperature (77 K) since the electron mean free path becomes equal to 0.3 µm at 77 K, this is comparable to the antidots spacing (0.2-0.4 µm).

**Conclusion**

In conclusion, the observation of the “ratchet” effect in antidot lattices realized on two materials (AlGaaS/GaAs and Si/SiGe) at liquid nitrogen temperatures means that it is possible to observe “ratchet” rectification at higher temperatures. For this aim it is necessary to fabricate such lattices with smaller periods. It gives perspectives to fabricate new electromagnetic radiation detectors sensitive to polarization, having linear response to the radiation power, and operating in a broad frequency ranges. Also, perspectives to fabricate macro-scale-sized current generators is proposed since our “ratchet” lattice acts as a current generator.

**Acknowledgments**

This work was financially supported by ANR/PROTOMICANO project and by the CNRS. The authors are very grateful to M.V. Entin and V.T. Granier for fruitful discussions. Also authors would like to thank J. Florentin, A.L. Barra, A. Richard, H. Aubert, H. Trugler, P. Reimann, A.D. Wieck, R. Martin, P.K. Marco, G. Hilt, A.D. Weid."