

Electrically Tunable, Low Noise, On-chip Inductors

This research aims to develop electrically tunable, low noise on-chip inductors using current carrying synthetic antiferromagnet (SAF) lines.

For the continued improvement and miniaturization of RF communications equipment such as cell phones and portable computers, there is an urgent need for high quality, integrated, tunable magnetic components. While electrically tunable capacitors (varactors) have been used for quite some time, the development of electrically tunable inductors has lagged.

The electrically tunable inductor being developed is based on a magnetic thin-film bilayer consisting of two ferromagnetic films (e.g. NiFe) coupled through an intervening nonmagnetic spacer layer (e.g. Ru). In such a system, the coupling through the spacer layer depends strongly on the thickness of the spacer. When the coupling favors anti-parallel alignment of the magnetic moments, as illustrated in the Figure 1, this structure is called a synthetic antiferromagnet (SAF). Magnetic domain formation, the primary cause of noise in magnetic devices, is suppressed in SAF structures. Such a coupled system of two magnetic layers can display a fascinating array of different behaviors depending on the strength of the interlayer coupling and the magnetic anisotropy.

Our work shows the variation of the magnetic susceptibility in response to magnetic fields generated by electrical current passing through the bilayer (Figure 2). This variation in magnetic susceptibility can be exploited to create tunable inductors.

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Investigators: Dr. Jander and Dr. Dhagat, OSU

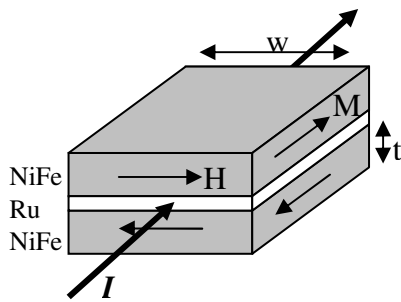


Fig.1. Structure and orientation of magnetic moments, M , of a synthetic antiferromagnet and direction of magnetic fields, H , acting on the layers due to a current, I , through the device.

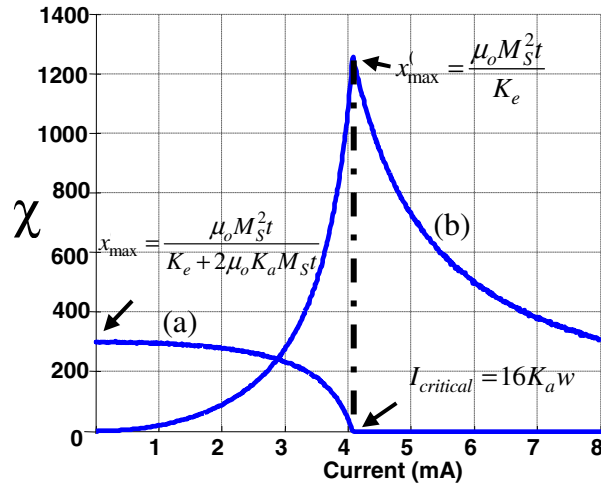


Fig.2. Magnetic susceptibility as a function of current in a SAF line. (a) Applied field parallel to the line (b) Applied field perpendicular to the line.