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Enhancement of VNA-FMR response from ultrathin magnetic layers on metallic buffers

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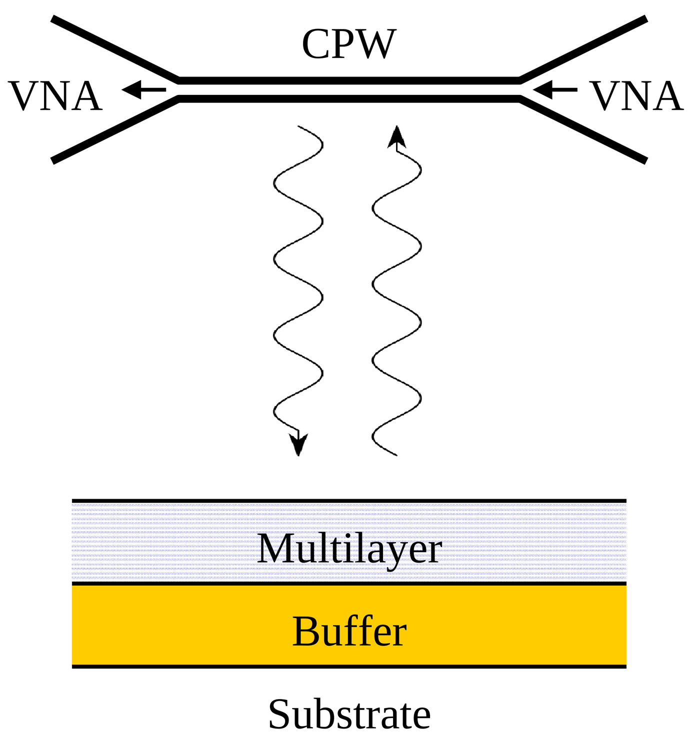
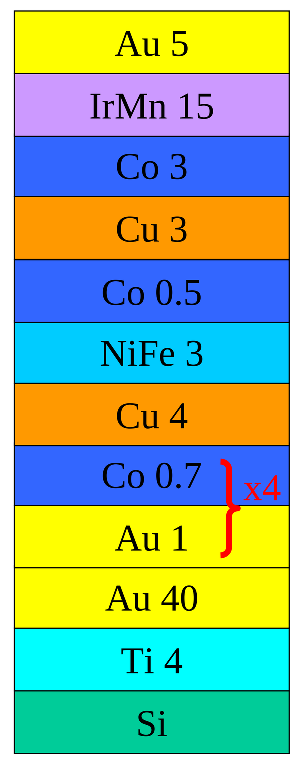
Introduction

Ferromagnetic resonance (FMR) based on VNA and CPW has become a common experimental tool for studying magnetization dynamic of magnetic films and nanostructures. Here we present a new effect of enhancement of the FMR absorption due to a conducting buffer layer.



Experimental details

- The multilayer films were deposited in a Prevac sputtering system .
- FMR was measured with a Vector Network Analyzer (VNA) on a coplanar waveguide (CPW). Measurements were done with constant frequency.
- The scattering matrix parameter S_{21} was measured in a field-sweep mode.



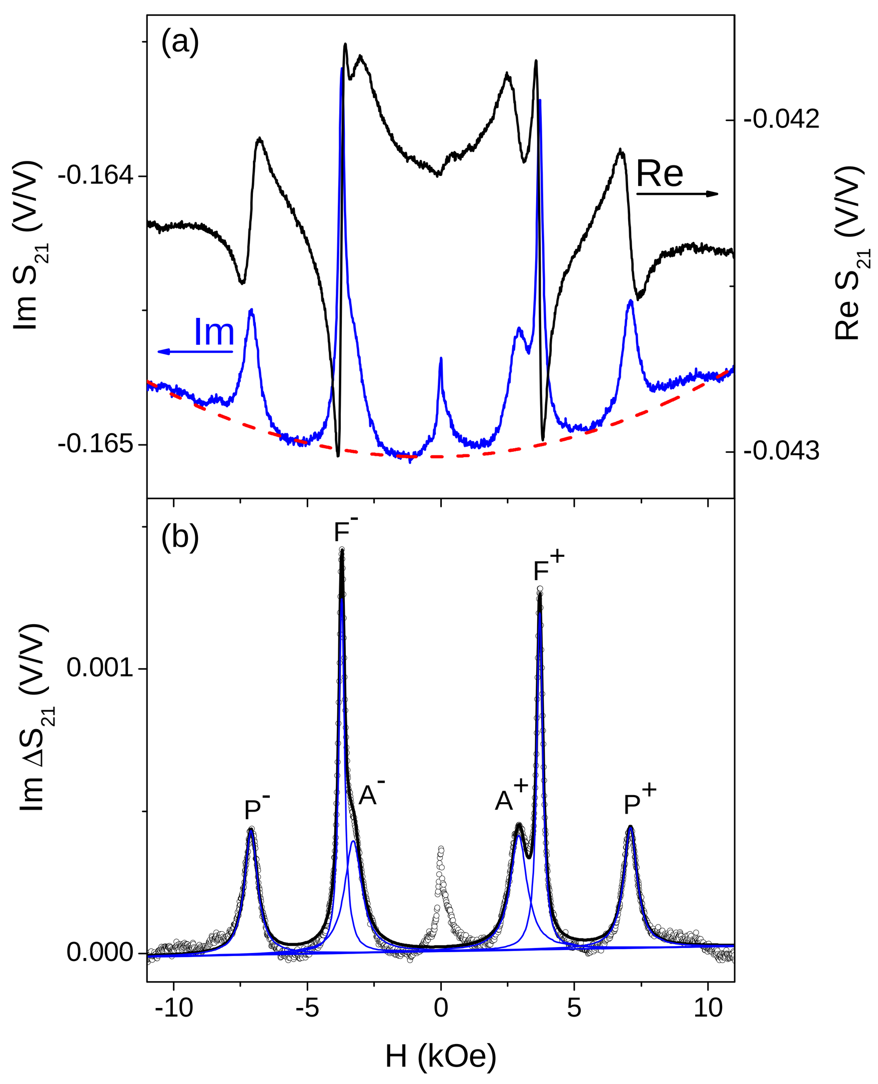
Results

- S_{21} can be seperated into magnetic and nonmagnetic contributions assuming that a reflection of microwave power is weak in our VNA-FMR set-up [4].

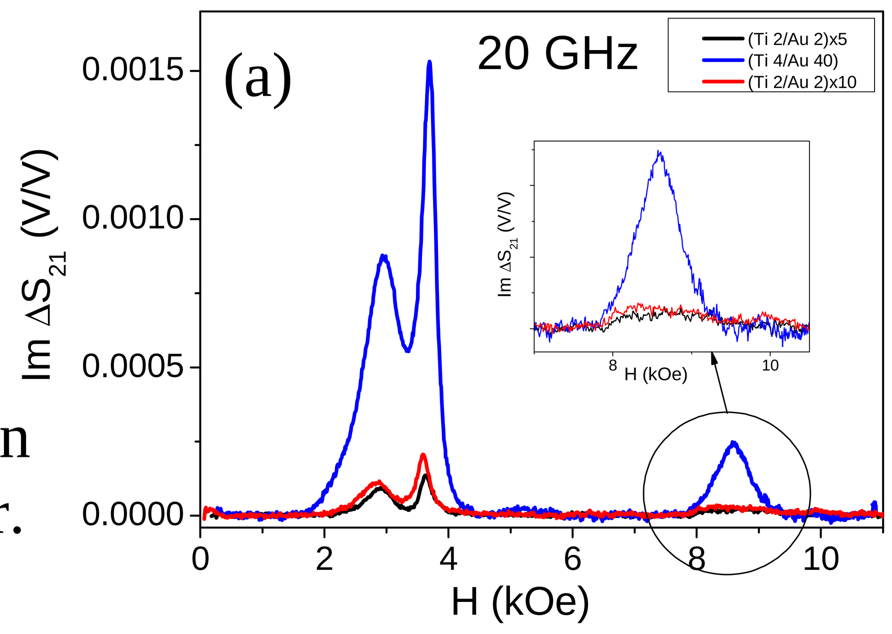
$$S_{21}(H,t) \approx S_{21}^0(H,t) + \frac{\chi(H)}{\chi_0}$$

$$\chi(H) \approx \chi_0 \Delta S_{21}(H)$$

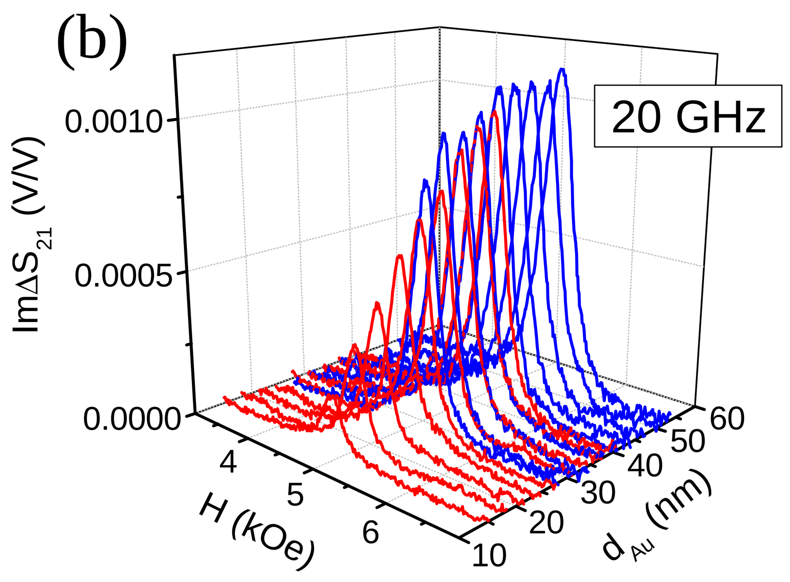
- The multilayer thin films comprise a [Au/Co]×4 perpendicular **polarizer**, an in-plane magnetized [Py/Co] **free layer** with Permalloy (Py), and an in-plane Co **analyzer** in contact with IrMn antiferromagnetic layer.



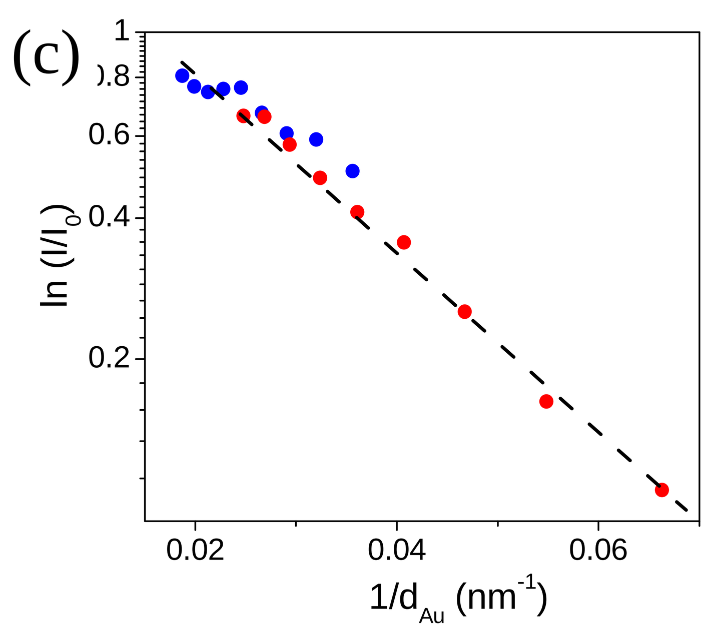
- Figure (a) shows that the FMR absorption of the samples in contact with different buffers depends on characteristics of the buffer.



- Figure (b) shows the enhancement of the FMR absorption as a function of the thickness of Au buffer.



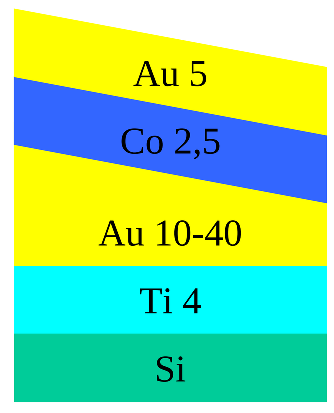
- Figure (c) shows that the FMR absorption intensity I is $\propto$exp(-1/buffer thickness) or $\propto$exp(-sheet resistance)



- S_{21} parameter also can be expressed as a function of thickness of conducting layer in proximity of CPW.

$$I \propto e^{-\frac{d_0}{d_{Au}}} = e^{-\frac{R}{R_0}}$$

$$\frac{S_{21}}{S_{21}^0} \propto \exp\left(-\frac{\frac{\gamma_0 \rho \delta^2}{2 Z_0 w}}{d}\right) \propto \exp\left(-\frac{d_0}{d}\right)$$



Summary

- We have shown that the intensity of FMR absorption in the single ultrathin Co layer measured with the use of coplanar waveguide (CPW) depends on the thickness d of the conducting Au buffer $\propto\exp(-d_0/d)$ or, equivalently, on the buffer sheet resistance $\propto\exp(-R/R_0)$.
- These findings are interpreted in terms of the microwave shielding effect by conducting films and an inhomogeneity of the dynamic magnetic field h related to the shielding [1-3]

References

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