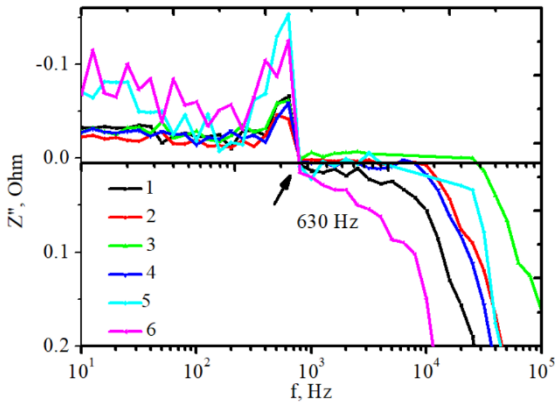
Sequential electric resonance in Fe nanofilms grown in a magnetic field

Korotkov K.A., Kasumov A.M, Dmitriev A.I, Netyaga V.V. Karavaevs V.M., Olifan O.I, Ievtushenko A.I.

Francevich Institute problems in Materials NASU
Omelyana Pricaka 3, Ukraine, Kyiv-142
k.korotkov@ipms.kyiv,ua

Studying the frequency dependence of the impedance components of Fe nanofilms (30 nm) grown in a magnetic field with a strength in the range H = (40 - 1200) E, it was found that at a frequency of 630 Hz the imaginary part of the impedance is equal to zero: $Z'' = \omega L - \frac{1}{\omega C} = 0$Z^"=ωL-1/ωC=0. That is, at a given frequency the Fe films undergo a state of equality of inductive ωL and capacitive $\frac{1}{\omega C}$ impedances: $\omega L = \frac{1}{\omega C}$. Since the phase angle φ of the phase shift between current and voltage is determined by the relationship $\tan\varphi = \frac{\omega L - \frac{1}{\omega C}}{R}$tanφ=(ωL-1/ωC)/R, where R is the active resistance, in this case φ = 0.

As it is known, when inductance and capacitance are connected in series in an equivalent impedance circuit, such a state is called a series electron resonance. The occurrence of resonance is demonstrated in the figure, which shows the frequency dependence of Z'' of Fe films grown on a layer of Gd_2O_3 in a constant magnetic field with strength H = 1200 (1) , 500 (2), 200 (3), 120 (4), 60 (5) and 40 (6) E. The vector $\vec{H}$ lies in the plane of the film. The frequency dependence was investigated using a computerized Solariton 1250 Series FRA setup.



The study shows that the effect of magnetic field strongly affects the morphology of Fe films. With increasing H from 40 to 1200 E, the morphology of the films changed from labyrinthine to solid, composed of interlocked iron islands of similar size and shape. The same clumped islands and the same resonance frequency of 630 Hz were observed for Fe films (30 nm) grown in a near field on silicate glass. It was shown that charge transfer in films composed of sticky iron islands corresponds to the percolation mechanism above its threshold.

The commonality of the elements of the structure of Fe films grown in a magnetic field - sticky islands of iron, suggests that the cause of resonance is the creation of conditions for the equality of induction ωL and capacitive $\frac{1}{\omega C}$ resistances $\omega L = \frac{1}{\omega C}$ in these structural formations at the frequency of 630 Hz.