

Magnetic dynamics of periodic and quasiperiodic arrays of NiFe nanostripes



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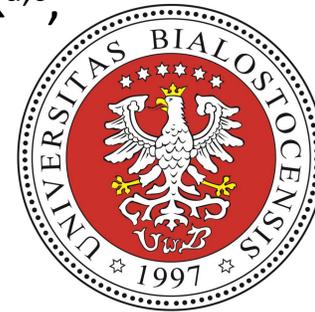
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Motivation (magnonic devices):

- information carriers: magnons (no electron flow, low energy consumption)
- high operational frequency (GHz, THz)
- better miniaturization compared to photonic devices
- information as amplitude or phase (parallel data processing)
- possibilities: integration with microwave photonic and electronics devices, applications in logic, communication, processing and storage of information [1,2]

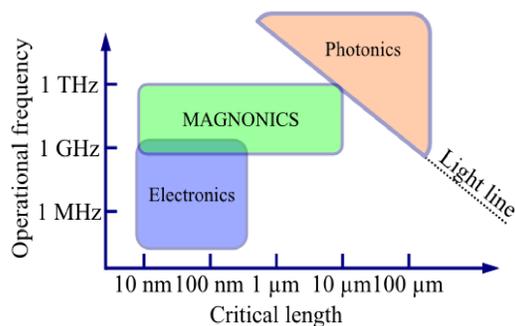


Fig. 1. The operation area of the electronics, photonics and magnonics in the logarithmic scale of the operational frequency and critical length [4].

We report on fabrication of one-dimensional magnonic crystals composed of periodic and quasiperiodic arrays of Ni₈₀Fe₂₀ stripes as well as their magnetization dynamics.

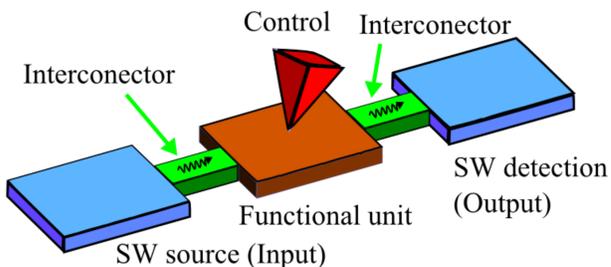


Fig. 2. Schema of the generic magnonic device. It comprise source and detecting units for spin waves, and functional unit controlled from outside. The units are interconnected by spin wave channels [2].

Magnonic crystals

- periodically modulated magnetic materials
- magnetic equivalents of photonic crystals
- magnonic forbidden and allowed frequency bands
- reprogrammable band structure
- properties dependent on the geometry but also on the magnetic properties of applied material [2]

Fibonacci (quasiperiodic) structure

$F_N = F_{N-1} + F_{N-2}$	N
$F_1 = B$	1
$F_2 = A$	1
$F_3 = A B$	2
$F_4 = A B A$	3
$F_5 = A B A B A$	5
$F_6 = A B A B A B A$	8

Fig. 3. Formation of the stripes array using Fibonacci sequence. Materials are: 350 nm wide Ni₈₀Fe₂₀ (A - green) and 100 nm wide air (B - blue).

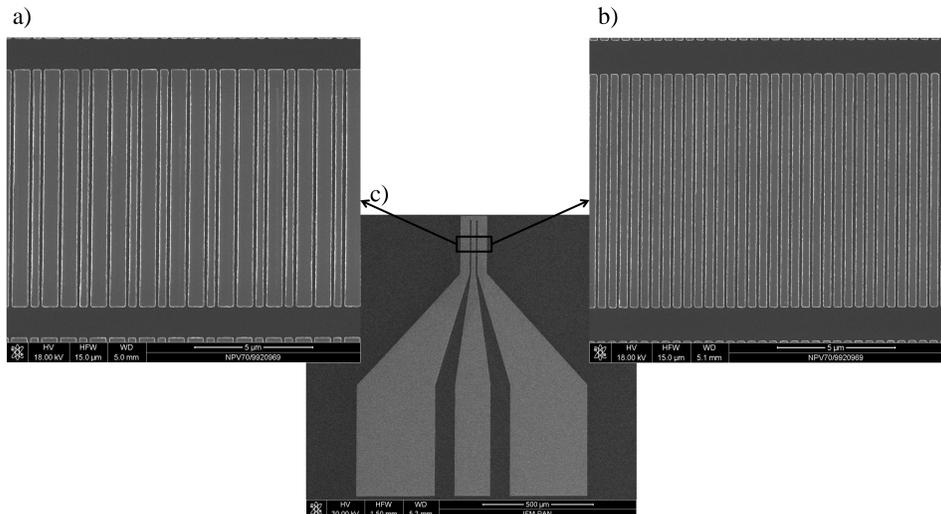
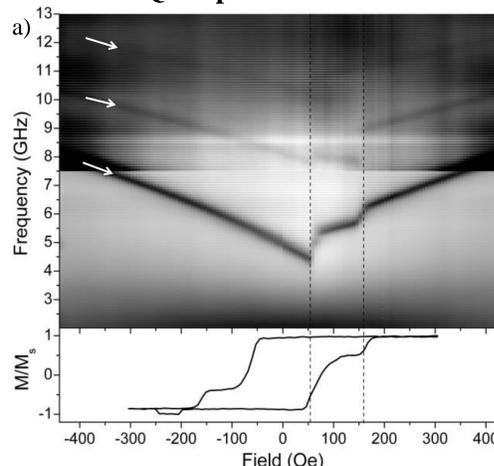


Fig. 4. SEM images of the quasiperiodic (a) and periodic (b) arrays of the Ni₈₀Fe₂₀ stripes and coplanar waveguide (CPW) for VNA-FMR measurements (c).

Acknowledgements

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Quasiperiodic structure



Periodic structure

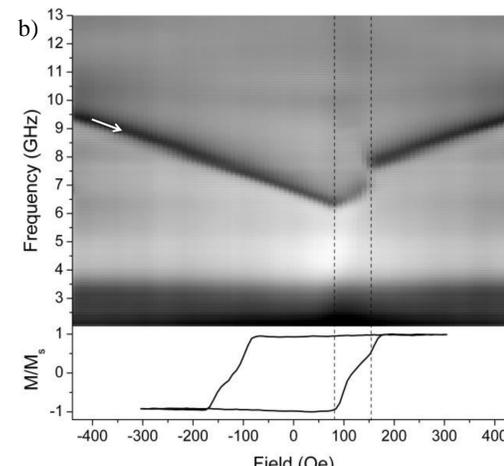


Fig. 5. FMR absorption spectra and MOKE hysteresis loops for quasiperiodic (a) and periodic (b) structures.

VNA-FMR spectra determined for magnetic field range corresponding to the minor loop and MFM measurements

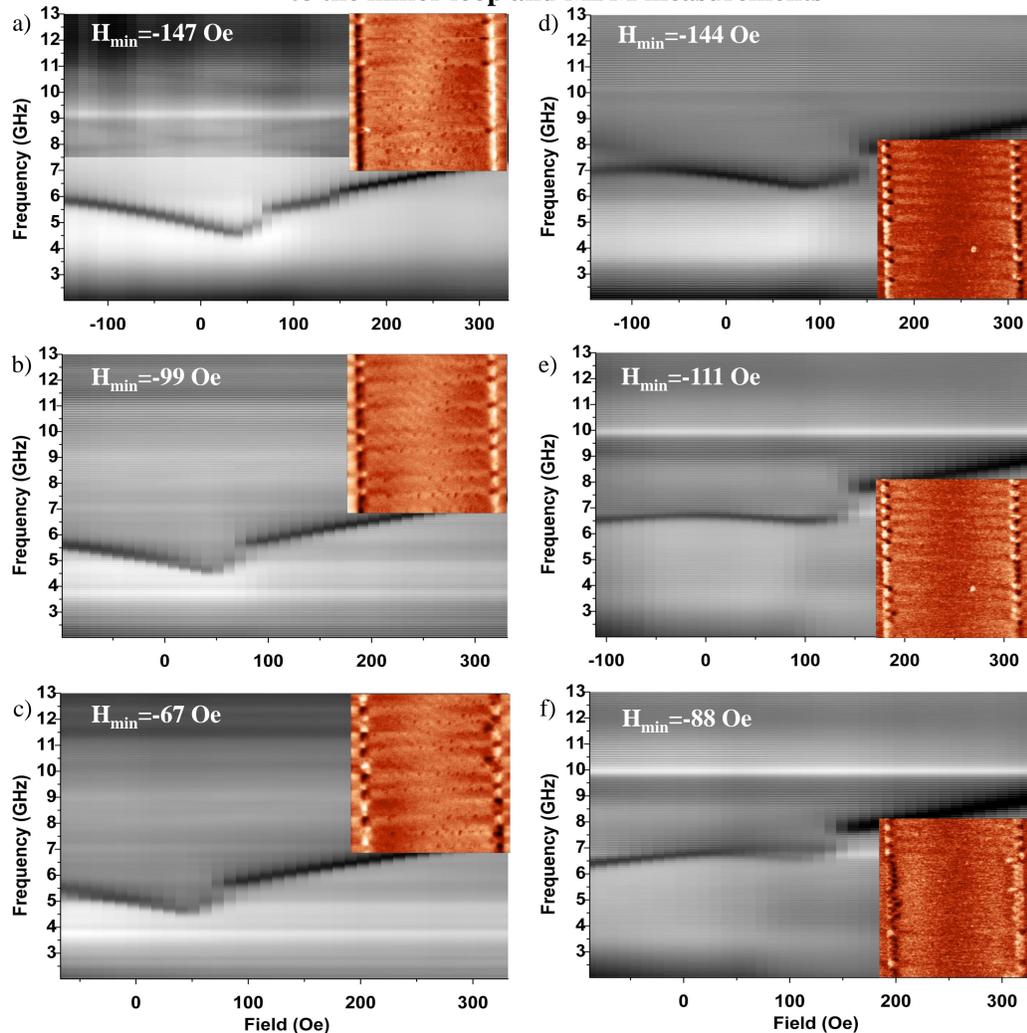


Fig. 6. FMR absorption spectra inside the minor loops and corresponding MFM images of magnetization state in the stripes in H_{min} for quasiperiodic (a-c) and periodic (d-f) structures.

Conclusion

Static and dynamic magnetic properties of the fabricated arrays of NiFe nanostripes were investigated. For the Fibonacci (quasiperiodic) structure two coercive fields were observed using VNA-FMR and MOKE techniques. Their values correspond to magnetization switching in wide (lower fields) and narrow (higher fields) stripes, which MFM measurements confirm. Dynamic measurements show not only acoustic (collective) excitation mode, but also optical mode, connected mostly to the excitation in the narrow stripes. For the periodic array of the nanostripes, only one coercive field was observed. What is more, antiparallel magnetization configuration in the consecutive stripes using MFM measurements was registered, which was also indicated by the VNA-FMR spectra.

Literature

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