A Switchable Neutron Spin Filter

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Motivation

The *optimal* neutron spin filter:

- high efficiency
- low absorption
- compact
- large bandwidth — allow for large divergence
- switchable — no need for a spin flipper
- no magnetic fields — no interaction with sample(environment)
- non-deflecting — simpler lay-out

Our aim:
A device fulfilling the last three requirements

Approach: Fe/Si supermirror on Si with

- easy axis of magnetization
- high remanence
- sufficient coercitive field

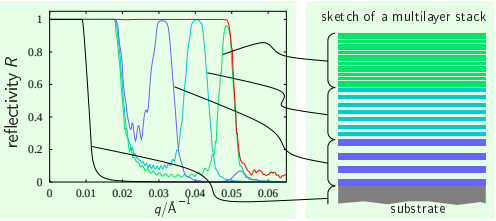
Preparation of the remanent polarizers by magnetron sputtering

Supermirror

multilayer: causes 'Bragg peaks'

stack of multilayers: overlapping 'Bragg peaks'

supermirror: 'multilayer' with layer thickness gradient



Acknowledgments

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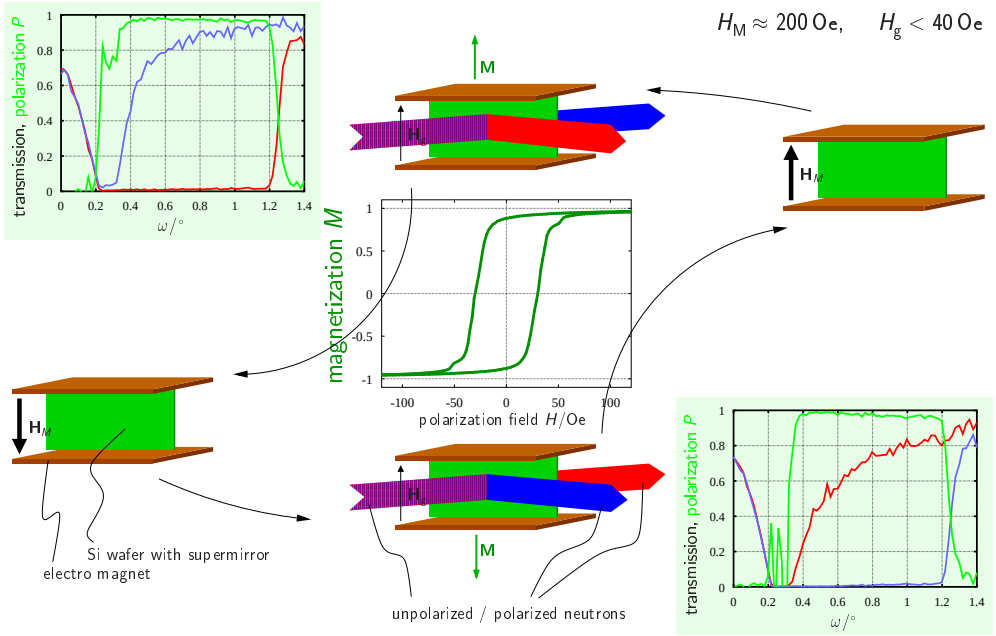
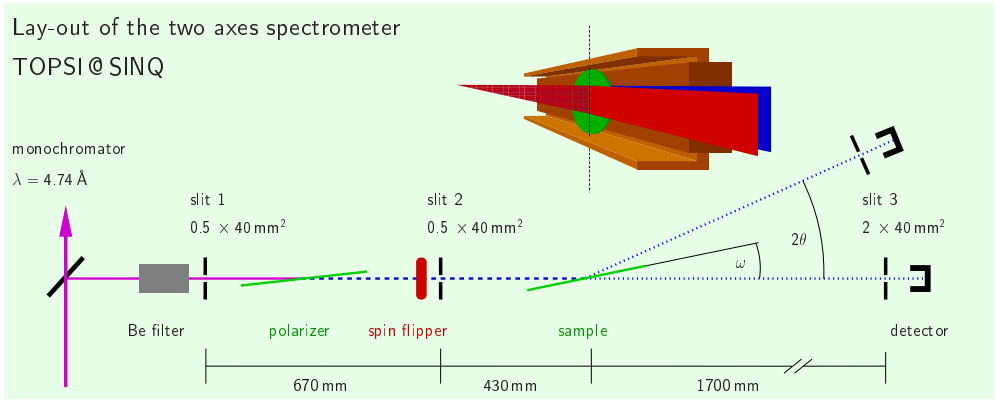
Application of a remanent polarizer

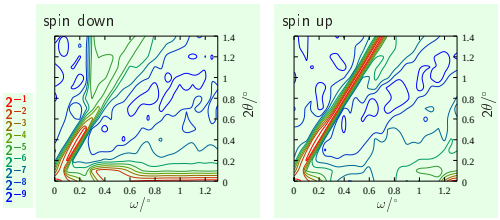


Set-up for transmission and reflectivity measurements



Off-specular scattering

$\omega/2\theta$ mapping for polarized neutrons, $\mathbf{M} \uparrow\downarrow \mathbf{H}_g$ to 'find' the lost intensity for $0.3° < \omega < 0.6°$



transmission: $2\theta = 0$
reflection: $2\theta = 2\omega$

Results

All shown experimental data were obtained from a Fe/Si supermirror of 299 layers ($m = 2.5$) on Si

The polarization

$$P = \frac{majority - minority}{majority + minority}$$

was calculated without any corrections

The polarizer can be switched by applying short magnetic field pulses.
During the measurement no field is required.

The *obtained* neutron spin filter:

- high efficiency — $P = 96\,\% \rightarrow 99\,\%$
- low absorption — $10\,\% \rightarrow 60\,\%$
- compact — ✘
- large bandwidth — $0.18 < q/nm^{-1} < 0.55$
- switchable — switching field $< 200\,Oe$
- no magnetic fields — ✔ coercitive field $> 30\,Oe$
- non-deflecting — ✔