ADVANCES IN SOFT MAGNETIC CERAMICS

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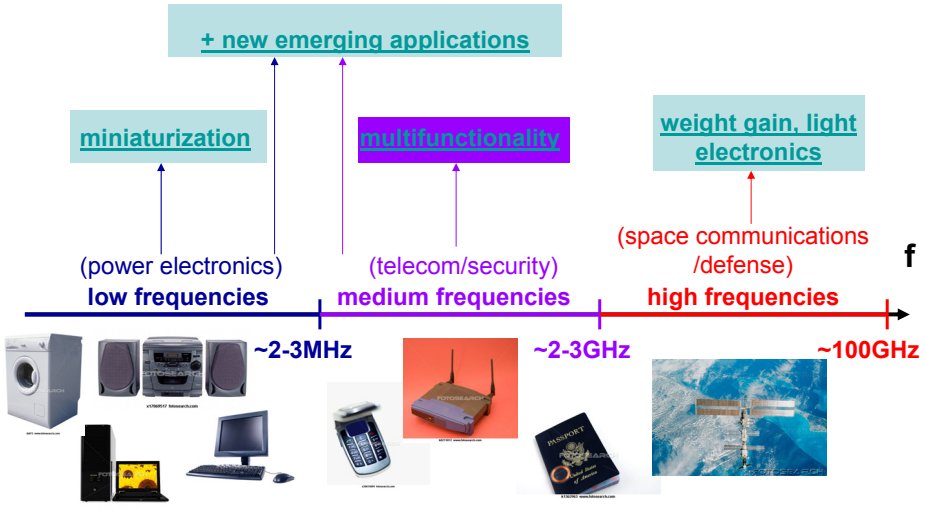
Soft magnetic ceramics consist a broad and well known family of functional technological materials with numerous applications over a broad frequency range

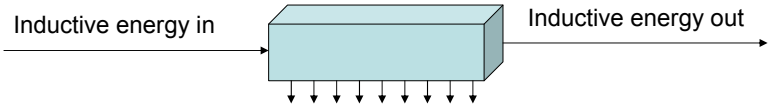
TRENDS



Miniaturization

Miniaturization is for some decades an ongoing trend in electronics aiming at continuously smaller device volume at equal performance

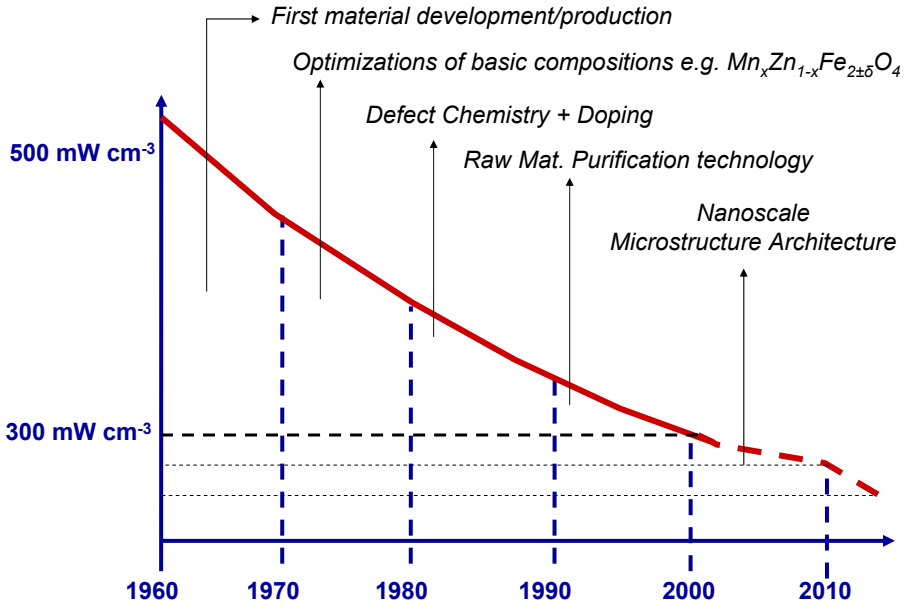
For magnetic components this means materials with low (heat) dissipation losses that do not overheat when their volume (and thus their heat convection surface) becomes smaller.



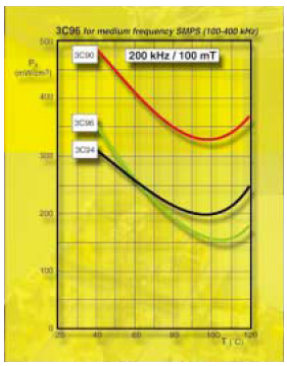
lost energy dissipated as heat ~ A

The history of miniaturization in soft magnetics

(case example: losses of cubic spinel $MnZnFe_2O_4$ at 100kHz, 200mT, 100°C)



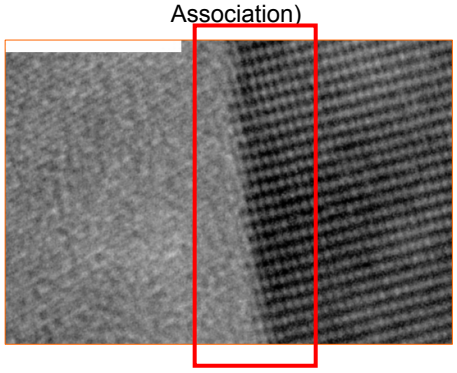
Miniaturization



Today, 275 mW/cc (100Khz, 200mT, 100°C)

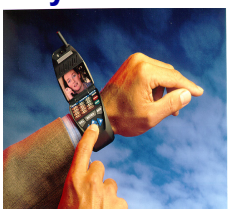
(Best material performance in the world)

(ECO-Award by the International Semiconductor Association)

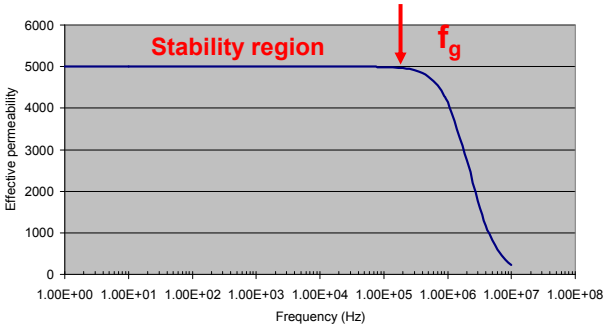


New Frontier: **<250 mW/cc** **(by 2013)**

Multifunctionality

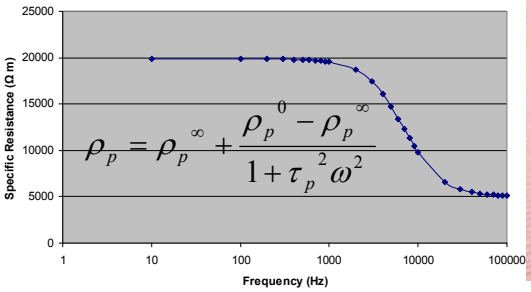


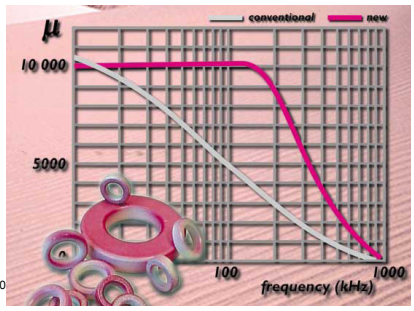
For magnetic materials this trend is translated as the development of new materials with extended frequency stability

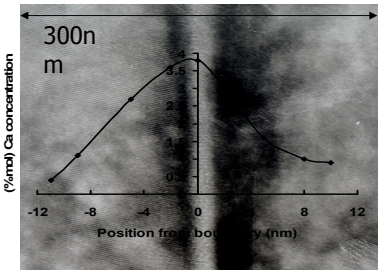


$$f_g = \frac{0.1\gamma B_s}{\mu_i}$$

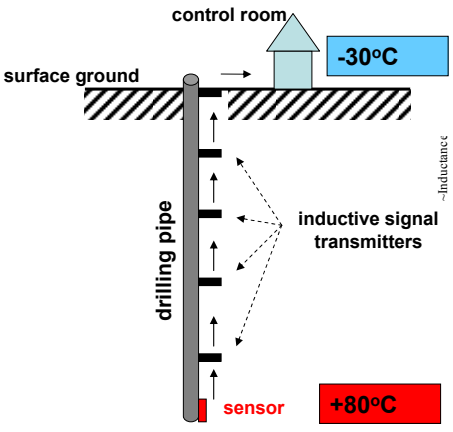
Multifunctionality



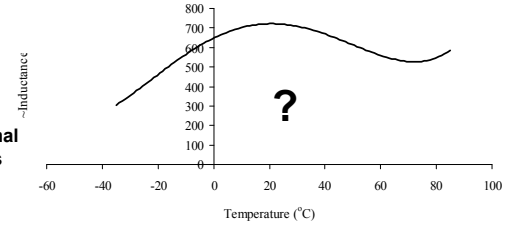




New emerging applications: Oil/Natural gas drilling



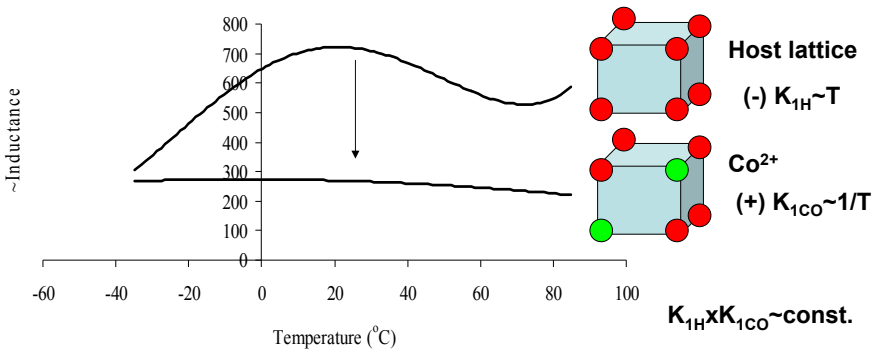
typical: inductance vs. temperature



New emerging applications: Oil/Natural gas drilling

Those signal transformers operate at very low fields and their permeability vs. temperature behavior resembles their magneto crystalline anisotropy constant vs. temperature behavior

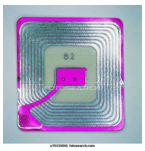
Develop mixed crystals having at certain positions ions with counteracting magnetocrystalline anisotropies



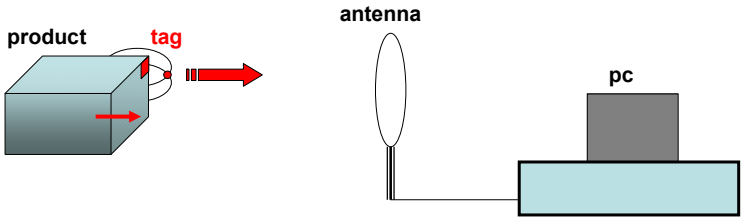
New future trend: Temperature stable materials (composite components)?

New emerging applications: RFID

the barcode



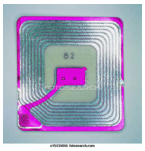
RFID tag



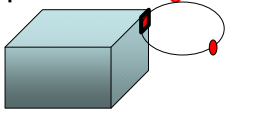
Metallic surfaces also emit and interfere which is a big disadvantage for RFID tags

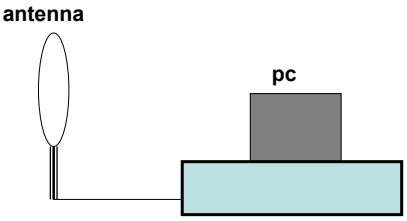
New emerging applications: RFID

the barcode



RFID tag

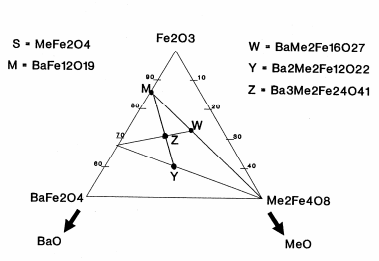


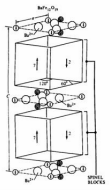


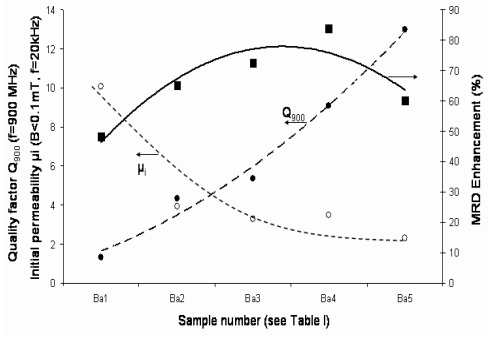
When the tag is backed by a properly designed material at RFID frequencies

The magnetic field does not penetrate into the product, is being shifted forward and the reading distance becomes significantly larger

New emerging applications: RFID

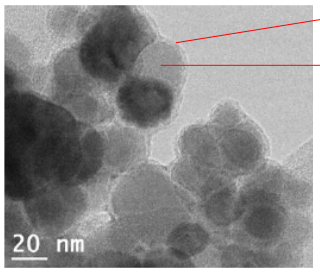






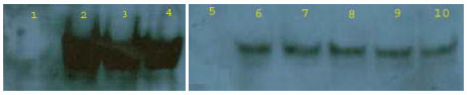
New future trend: Emerging applications for hexagonal materials

New emerging applications: Diagnosis on Prostate Cancer

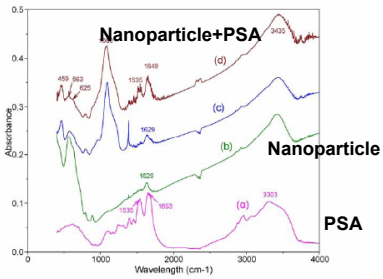


Silica Coating

Magnetic nanoparticle



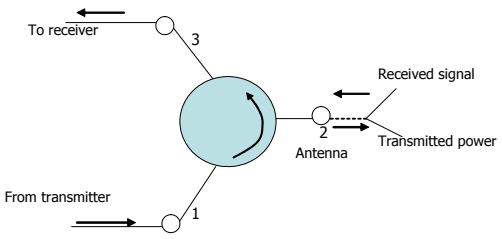
"Western blotting" indicating successful bonding of nanoparticles with prostate cancer antibodies



Space Communications (~94 GHz)

Shuttles for space missions need (and even more in the future) to be light. Materials helping towards this goal are always desirable by the European or American Space Agencies.

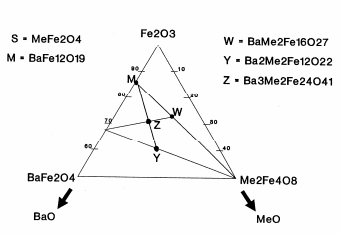
Special high frequency magnetic components (operating at 94GHz may provide the necessary functionality to reduce the number of antennas.

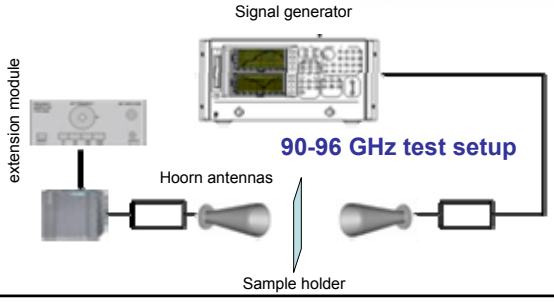


The magnetic component operates as a 3-way valve allowing the same system to operate either to receive signals or to transmit signals

Space Communications

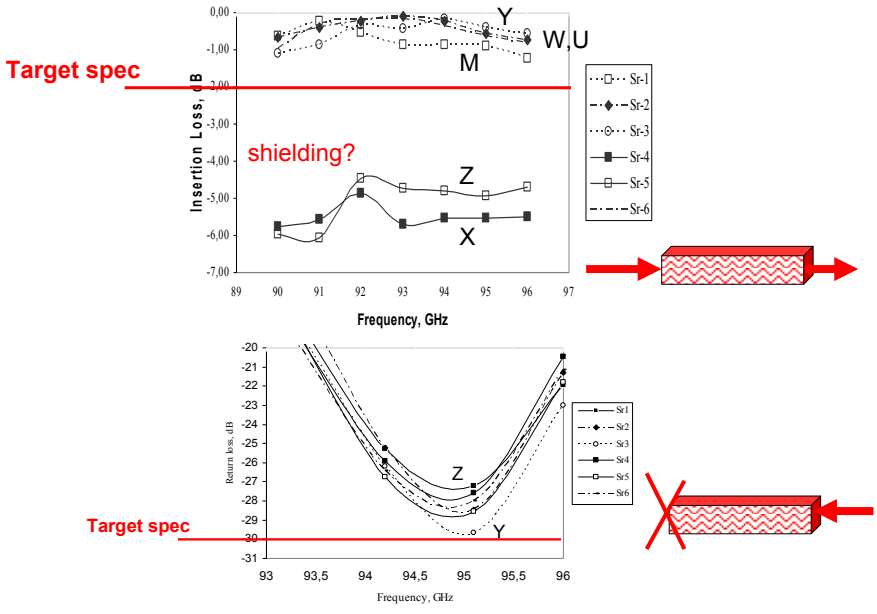
This is a totally unexplored area at 94 GHz. No literature data or information is available on material behavior at this region





Space Communications

(Measurements at space conditions are scheduled before Christmas at ESA)



Conclusive Remark

The continuous evolution in the applications of informatics, telecommunications and microelectronics brings new challenges for new and better performing magnetic materials. The case examples of this presentation were only a few.

As there is no serious alternative to high frequency induction there are no reasons to believe that this will change in the future.

The successful response to these challenges pas through interdisciplinary scientific efforts towards fundamental understanding of the application characterstics, the material lattice and the processing technology for the achievement of the desired microstructure.

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