Subterahertz FMR frequency and coercivity control in hexaferrites

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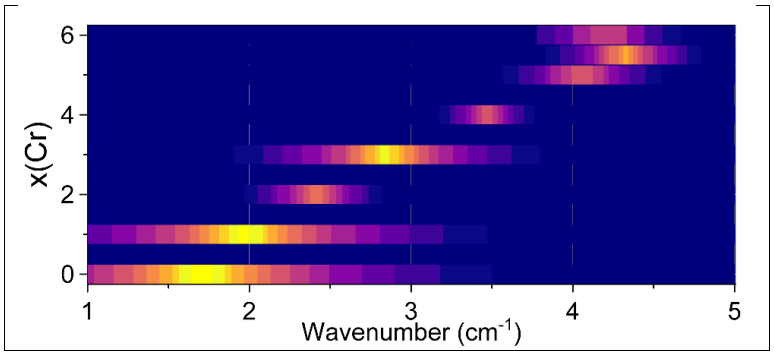
Here, we demonstrate a way to realize fine control of important functional characteristics of M-type hexaferrites, the well-known hard magnetic materials. We managed to synthesize submicron particles of Cr-substituted strontium hexaferrite $SrCr_xFe_{12-x}O_{19}$ with a wide range of substitution degrees, x = 0 – 8. After thorough investigation of morphology, structure, magnetic parameters (hysteresis loops, Curie temperatures, coercive forces) and magnetodynamics (subterahertz/terahertz absorption, presented by narrow zero-field ferromagnetic resonance), we conclude that there has been a significant enhancement in functional magnetic characteristics of the compound. We show that with variation of substitution degree x(Cr), one can finely tune the coercive force of $SrCr_xFe_{12-x}O_{19}$, ranging from a moderate 4.4 kOe at x=0 to an outstanding large value of 13.9 kOe at x=5.5. The frequency of a natural (i.e., in zero external magnetic field) ferromagnetic resonance allows tuning in the range of 51-129 GHz. This result is achieved by substitution-induced increase in the anisotropy field H_a, that reaches its maximum value at x=5.5. Though the substitution results in a decrease in both the magnetocrystalline anisotropy K_1 and the saturation magnetization M_s and, as is well-known, $Ha \sim K_1/M_s$, the rise in H_a is promoted by the difference in the slopes of $K_1(x)$ and $M_s(x)$ declines.



Pic.1 Evolution of terahertz absorption with increase of substitution degree x in $SrCr_xFe_{12-x}O_{19}$.

The possibility of targeted wide-range tuning of the most important magnetic parameters is crucial for the applicational potential of the studied magnetic materials in modern technologies such as high-speed/high-density data transfer, telecommunication, spintronics. Thus, Cr-substituted hexaferrites are highly demanded for the progress in rare-earth-free magnets, terahertz optoelectronics and spintronics.

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