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Posters

Igor V Shchetinin et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Influence of production methods on structure and magnetic properties of $NdFe_{11}Ti$ based alloys and their nitrides

Igor V Shchetinin, Mark V M V Zheleznyi, Mikhail V Gorshenkov, Andrey I Bazlov, Anton V Kamynin and **Alexander G Savchenko**
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Compounds based on Fe and rare earth elements with the structural type $ThMn_{12}$ have been known for more than 30 years and have fundamental magnetic properties comparable to the compound $Nd_2Fe_{14}B$. Nitrides of $NdFe_{12}$ compound have higher properties than those of $Nd_2Fe_{14}B$ compound: saturation magnetization 1.66 T, Curie temperature 550°C and anisotropy field 6.4 MA/m. However binary compounds RFe_{12} (R is rare-earth element) are stable only in the thin films forms. To stabilize this phases with $ThMn_{12}$ structural type transition metals that replace Fe are used $RFe_{12-x}M_x$ (where M = Al, Cr, V, Ti, Mo, W, Si or Nb) At present time these alloys have no practical application due to small values of hysteresis properties compared to the Nd-Fe-B system. In this regard, investigation of structure formation and magnetic properties of $NdFe_{11}Ti$ alloys quenched from the liquid state and subjected to heat treatment is an urgent task. As a result of these studies, methods and regimes for producing of $NdFe_{11}Ti$-$NdFe_{11}TiN$ compounds have been tested: melting, homogenizing annealing, quenching from a liquid state, and nitriding. It is shown that homogenizing annealing at a temperature of 1100°C for 168 h makes it possible to obtain a ferromagnetic phase with a structural type of $ThMn_{12}$. An almost single-phase state (97%) was produced by quenching from the liquid state without using prolonged annealing which increases the grain size of the $NdFe_{11}Ti$ phase to about 150 nm. It is shown that nitriding of the alloy leads to an increase in main magnetic hysteresis properties. The maximum magnetic hysteresis properties were obtained using a combination of quenching methods from the liquid state and nitriding: Hc = 1053 Oe, σr = 46 emu/g, σs = 139 emu/g.

Figure1: The results of transmission electron microscopy of samples after quenching from the liquid state.

Recent Publications

1. Glezer A M, Timshin I A, Shchetinin I V et al. (2018) Unusual behavior of long-range order parameter in Fe_3Al superstructure under severe plastic deformation in Bridgman anvils. Journal of Alloys and Compounds DOI: 10.1016/j.jallcom.2018.02.124.
2. Romankov S, Park Y C and Shchetinin I V (2018) Structural transformations in (CoFeNi)/Ti nanocomposite systems during prolonged heating. Journal of Alloys and Compounds 745:44-54.
3. Savchenko A G, Medvedeva T M, Shchetinin I V et al. (2017) Phase-structural state diagrams and hysteresis properties of rapidly solidified alloy $Nd_{10.4}Zr_{4.0}Fe_{75.1}Co_{4.1}B_{6.4}$ after heat treatment. Journal of Alloys and Compounds DOI: 10.1016/j.jallcom.2017.01.002.
4. Menushenkov A P, Ivanov V G, Shchetinin I V et al. (2017) XMCD study of the local magnetic and structural properties of microcrystalline NdFeB-based alloys. JETP Letters 105(1):38-42.

Biography

Igor V Shchetinin has completed his PhD in the year 2012 from National University of Science and Technology. He is the head of X-ray structure analysis and diagnostic of materials laboratory. He has published more than 60 papers in reputed journals and has been serving as an Editorial Board Member of repute.

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Igor V Shchetinin et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Structure and magnetic properties of alloys based on $SmFe_{17}$ nitride after serve plastic deformation by torsion

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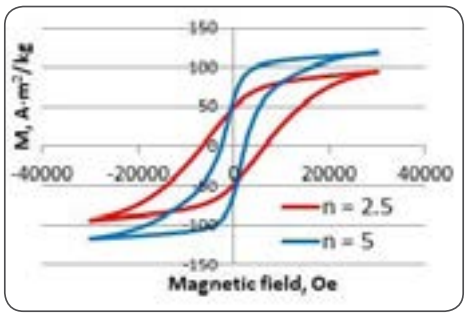
The nitrides of the Sm_2Fe_{17}-based alloys are promising for the development of permanent magnets because they have a high magnetic crystalline anisotropy constant, Curie temperature, and are cheaper than compounds like $Nd_2Fe_{14}B$. In this connection, study of structure formation and magnetic properties of alloys based on nitrides of the Sm_2Fe_{17} compound obtained by the methods of extreme effects is the actual task. It this work, we show that alloys in the initial state and after the hydrogenation and dehydrogenation processes contained the main phase of Sm_2Fe_{17} and a small amount (<2%) of α-Fe nitriding resulted in increased of Sm_2Fe_{17} lattice spacing without formation of new phases. After severe plastic deformation by torsion (SPDT), diffraction patterns of the alloys revealed a strong broadening of the diffraction lines which indicated the formation of a dispersed structure and was confirmed by SEM data: the formation of an equiaxial structure in the sample with an average grain size of 20 nm. In addition, according to X-ray diffraction analysis, the fraction of α-Fe increased in the SPDT process due to the local heating of the sample and leads to decomposition of $Sm_2Fe_{17}N_{2.8}$ phase. The hysteretic properties of the alloys changed in an extreme: under deformations with n = 2.5, the coercive force was increased to 6.5 kOe, and an increase in the degree of deformation led to a decrease in the coercive force, with the formation of a characteristic loop of magnetic hysteresis. As a result of the deformation at 77 K, nitride decomposition was not observed which confirms the heating of the material during deformation at room temperature.



Recent Publications

1. Glezer A M, Timshin I A, Shchetinin I V, et al. (2018) Unusual behavior of long-range order parameter in Fe_3Al superstructure under severe plastic deformation in Bridgman anvils. Journal of Alloys and Compounds DOI: 10.1016/j.jallcom.2018.02.124.
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4. Menushenkov A P, Ivanov V G, Shchetinin I V, et al. (2017) XMCD study of the local magnetic and structural properties of microcrystalline NdFeB-based alloys. JETP Letters 105(1):38–42.

Biography

Igor V Shchetinin has completed his PhD in the year 2012 from National University of Science and Technology. He is the head of X-ray structure analysis and diagnostic of materials laboratory. He has published more than 60 papers in reputed journals and has been serving as an Editorial Board Member of repute.

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Ahmed Faramawy et al., Res. Rev. J Mat. Sci. 2018, Volume 6
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Effect of co-sputtering deposition power on structure and properties of Fe doped ZnO thin films

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Fe doped ZnO (FeZO) thin films were deposited using magnetron co-sputtering (DC for Fe and RF for ZnO) on silica and silicon substrates. To better control the Fe-doping in the 1% atomic range, instead of reducing the DC power (which produced instabilities of the DC source), we performed the DC sputtering through a grid with different mesh size to block part of the Fe atoms. The structural, optical and magnetic properties of 150 nm thick FeZO films were investigated. Single phase hexagonal wurtzite structures in all samples were confirmed by GIXRD. RBS and EDX were used to determine the elemental composition and stoichiometry of the ZnO films doped with Fe. A variation of the FeZO bandgap from 3.21 eV (pure ZnO) to 3.33 eV (5% Fe in ZnO) has been obtained from the optical transmittance using UV-Vis optical spectroscopy. Moreover, the room temperature M–H hysteresis loops for FeZO films were investigated by vibrating sample magnetometer (VSM). A ferromagnetic behavior was obtained in the pure ZnO film, possibly due to surface defects such as oxygen vacancies, whereas a paramagnetic one was found for the FeZO ones. These various properties make FeZO in thin film form a promising candidate material in wide range applications in photocatalysis and in magneto-optical devices, which we plan to investigate in our future work.

Biography

Ahmed Faramawy is the PhD student of NanoStructures Group from the Dept. of Physics and Astronomy in the University of Padova (via Marzolo 8, I-35131 Padova, Italy).

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Notes:

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E-Poster

Imran Sadiq, Res. Rev. J Mat. Sci. 2018, Volume 6
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Synthesis and investigation of Pr-Cu substituted CTAB assisted microwave absorbing nano-material suitable for super high frequency applications

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The main theme of this work was to synthesize and investigate the microwave absorbing material (MAM). For this purpose, a rare earth Pr^{3+} and transition element Cu^{2+} substituted series of X-type hexaferrites $Sr_{2-x}Pr_xCo_2Fe_{28-y}Cu_yO_{46}$ with concentration (x = 0, 0.02, 0.06, 0.1 and y = 0, 0.1, 0.3, 0.5) was synthesized by adopting the sol gel method. The thermal analysis was carried out to know the sintering temperature at which the single x-type phase can be attained. The XRD patterns show the single phase for all the samples. The Pr-Cu substitution in pure x-hexaferrites changed the structural parameters. The nano-particle size of the material was confirmed from the TEM analysis. The HRTEM image and SAD pattern indicates that the material is well crystallized. The FTIR analysis also confirms the single phase for prepared materials. The increment in dielectric properties with Pr-Cu substitution was observed. The magnetic properties of the material were enhanced with additives. The material exhibited the minimum value of reflection loss (microwave absorption) at higher frequencies which makes this material useful to act as microwave absorbing material (MAM) for super high frequency (SHF) devices.

Recent Publications

1. Imran S (2017) Study of structural, magnetic and microwave absorption properties of Dy-Mn substituted nanosized material in X-band frequency range. Journal of Alloys and Compounds 715:284-290.
2. Imran S (2018) Synthesis and electrical behavior of Ni-Ti substituted Y-type hexaferrites for high frequency application. Journal of Magnetism and Magnetic Materials 451:787-792.
3. Imran S (2016) Tunable microwave absorbing nano-material for X-band applications. Journal of Magnetism and Magnetic Materials 401:63-69.
4. Imran S (2017) Multiferroics $BiMn_1–xAlxO_3$ nanoparticles: Synthesis, characterization and evaluation of various structural, physical, electrical and dielectric parameters. Journal of Magnetism and Magnetic Materials 433:71-75.
5. Imran S (2016) Enhanced microwave absorption properties of CTAB assisted Pr–Cu substituted nanomaterial. Journal of Magnetism and Magnetic Materials 414:198-230.

Biography

Imran Sadiq has earned his PhD in 2014. Currently he is working as Assistant Professor in Centre of Excellence in Solid State Physics, University of the Punjab, Lahore, Pakistan. Currently, he is supervising three research students. He has published more than 25 research papers in international peer reviewed journals.

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Accepted Abstracts

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Magneto-electronic and thermodynamic properties of $Cr_2GdGe_{1-x}Sn_x$ Heusler alloys

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The main investigation's goal of this work is to give a report on the structural, mechanical, magneto-electronic and thermodynamic properties of the quaternary full-Heusler alloys $Cr_2GdGe_{1-x}Sn_x$ for different concentrations x ($0 \leq x \leq 1$). The present result was done by means of DFT calculations. The effect of concentration x on the calculated lattice parameters and bulk modulus, shows a linear dependence for the lattice parameters with marginal downward bowing parameters equal to 0.0457 Å, while a nonlinear behavior is observed for the variation of bulk modulus with disorder parameter equal to 4.696 GPa. The estimated elastic constants confirm the mechanical stability of our compounds. The thermodynamic stability was explored on the basis of the regular solution model. Furthermore, the temperature and pressure effects on the bulk modulus, heat capacities and Debye temperatures are also computed and discussed in details. The magneto-electronic calculations reveal that all the presented compounds exhibit a HMF behavior. Finally, we can report that due to the potential half-metallicity exhibited by our investigated alloys, these compounds could be used for spintronic application.

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Thermal conductance of zero modes on the surface boundary of a Weyl semimetal

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Thermoelectric conductance of Dirac materials and in particular zero modes reveal the effect of topology. Weyl semimetals with a boundary at $z=0$ gives rise to chiral zero modes without backscattering, resulting in a significant contribution to thermal conductivity. By doping the surface with paramagnetic impurities, backscattering is allowed and the thermal conductance is suppressed. We attach a thermal reservoir at the edge of the sample and study the thermal and electrical conductance. For the ballistic and mesoscopic situations, quantum fluctuations cause oscillations of the thermal and electric conductance. The thermoelectric conductance varies periodically with the voltage bias. We compare the thermal conductance with and without magnetic impurity scattering and observe the effects of topology. An experimental set-up is proposed to test this theory.

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Structural, electronic, magnetic and transport properties of $Co_2Fe_{1-x}Cr_xSi$ Heusler alloys

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The effect of Cr substitution in place of Fe on the structural, electronic, magnetic and transport properties of the Co_2FeSi alloy is studied. A comprehensive structural analysis is done using X-ray diffraction (XRD) and extended X-ray absorption fine structure (EXAFS) spectroscopy. Quaternary Heusler compounds $Co_2Fe_{1-x}Cr_xSi$ with Cr content (x = 0.1, 0.3, 0.5) were found to crystallize in cubic structure. The synchrotron-based EXAFS studies reveal that the anti-site disorder increases with the increase in Cr concentration. The saturation magnetization values in all the alloys are found to be less than those expected from the Slater-Pauling rule, which may be due to some inherent disorder. A detailed resistivity analysis in the temperature range of 5-300 K is done, taking into account different scattering mechanisms. The residual resistivity ratio is found to decrease with increasing Cr concentration. A disorder induced resistivity minimum due to weak localization effect is seen for x=0.5. The resistivity measurements also indicate that the half-metallic character survives up to 100 K for x=0.1, whereas the alloys with x=0.3 and 0.5 show signature of half-metallic nature even at higher temperatures. First-principles calculation done with a more robust exchange-correlation functional (namely HSE-06) confirms the half-metallicity in the entire concentration range. Theoretically simulated band gap and magnetic moments compliment the experimental findings. All these properties make $Co_2Fe_{1-x}Cr_xSi$ a promising material for spintronics.

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Detection of small size defect in the insulated pipe using pulsed eddy current

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The pulsed eddy current (PEC) system enables to detect the wall thinning and defects without removing the insulation, but the resolution is poor and data analysis is not easy. In this study we developed PEC system to detect wall thinning of Ferro magnetic steel pipes, which is capable of decimating the thickness change of pipe line through 95 mm fiber glass thermal insulator and 0.4 mm Aluminum (Al) cladding. Peak amplitude and time to peak of the PEC signals obtained from various thickness regions of the test sample were analyzed in time domain. Results show a very good change corresponding to the sample thickness. In addition to time domain analysis, wavelet based signal processing technique was applied, in specific wavelet packet analysis based algorithm that utilizes the encoding technique was developed in MATLAB platform. Results were visualized and well accords with the time domain analysis.

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Room temperature multiferroics in rare earth doped $BiFeO_3$ ceramics

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Multiferroics is a special and rare class of unique materials that exhibit the coexistence of two or more ferroic order parameter particularly in single phase materials at the specific temperature. In an attempt to enhance multiferroicity in $BiFeO_3$ (only the highly promising materials which shows ferroelectric Curie temperature (Tc= 1103 K) and antiferromagnetic Neel temperature (TN=643 K) with large value of leakage current), rare earth doped $BiFeO_3$ bulk ceramics are prepared by novel slow step sintering schedule which shows monophasic character with significant reduction of leakage current. Incorporation of rare earth ion (for example Gd) nucleates and develops orthorhombic grain growth habit by suppressing the original rhombohedral phase. We observed room temperature enhanced P-E as well as M-H loop when a rare earth ion (Gd) is critically optimized at a certain level in the composite matrix of Bi Gd FeO_3. We recommend that this class of materials have the potential ability to couple both ferroelectric and magnetic order parameter which is the basic blocks of future generation spintronics devices, biferroic memory and electric field controlled ferromagnetic resonance devices. The basic idea on the subject as well as important experimental finding in this direction will be discussed in the talk.

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Improvement of magnetic properties using high magnetic fields

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This research project had two prongs: developing materials (usually non-magnetic) to be used in the construction of high-field electromagnets, and using these high-field magnets in the development of new permanent magnetic materials. We developed nanostructured composite conductors with very high mechanical strength for our magnet coils, and we also developed very strong structural materials to reinforce those coils. The work done in this study was a key factor in the recent establishment by the US of new world records in high magnetic field production. Because of the high cost of Nd metals, our study on permanent magnetic materials was focused on improving current alternatives to Nd-based magnetic materials. The bulk Mn80-xGa20x system, for example, has hard magnetic properties but a low magnetic moment. We developed two ways to enhance the magnetic moment. The first is magnetic field annealing (MFA), which improved the magnetic moment by more than 50%. The second is to partially replace Mn with other alloy elements, such as FeB compound, resulting in a hard magnetic material with an increased magnetic moment. The addition of FeB was found to have doubled the magnetic moment of the binary system. The other example is Iron-Cerium-Boron (Fe-Ce-B). We enhanced the magnetic properties of Fe-Ce-B ribbons by engineering both microstructure and volume fraction of the Ce2Fe14B phase through optimization of the chamber pressure and the wheel speed necessary for rapid solidification achieved.

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Structural and magnetic properties of TbNi-substituted calcium strontium M-type nano-structured hexaferrites

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The effect of TbNi substitution on the structural and magnetic properties of $Sr_{0.5}Ba_{0.5-x}Tb_xNi_yFe_{12-y}O_{19}$, (x = 0.00–0.10; y = 0.00–1.00) hexaferrites that are synthesized by sol-gel auto combustion method is investigated. After synthesis of the samples by the sol-gel method they were characterized by (FTIR) Fourier transform infrared spectroscopy, (XRD) x-ray diffraction, (SEM) scanning electron microscopy, (TEM) transmission electron microscopy and (VSM) vibrating sample magnetometry. The single phase of an M-type hexaferrite structure has been confirmed by X-ray diffraction analysis. The lattice parameters were found to increase by increasing TbNi contents, and are thought of due to ionic sizes of the cations implicated. The TbNi has been completely soluble in the lattice. The scanning electron microscopy and transmission electron microscopy results clearly indicate that the grain size decreases with an increase of TbNi substitution. The coercivity values (1640–2170Oe) of all samples exhibit in the M-type hexaferrite range and shows increased anisotropy by the substitution of TbNi, while the size of nanoparticles was drastically reduced between 20 and 30 nm. The fine nanoparticles with increased anisotropy are very attractive in a lot of applications, such as perpendicular recording media, high-frequency applications and for improving the signal to noise ratio.

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Non-local spin transport in topological insulator nanowires

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The momentum and spin of charge carriers in the topological insulators are constrained to be perpendicular due to strong spin-orbit coupling. Sb_2Te_3 is one of the topological insulator materials with a bulk band gap of 0.28 eV and simple surface states consisting of a single Dirac cone in the band gap. We have synthesized single crystalline Sb_2Te_3 nanowires using low pressure catalytic chemical vapor deposition, via vapor-liquid-solid growth mechanism. Two levels of aligned e-beam lithography were used to pattern non-magnetic outer Au leads and two magnetic tunnel junction inner leads on individual Sb_2Te_3 nanowires. The tunnel junction leads consist of a free Py ($Ni_{80}Fe_{20}$) layer, whose magnetization determines the magnitude and direction of spin current injected into the Sb_2Te_3 nanowire. Measurements of the device resistance between the two Au leads reveal that the Au/Sb_2Te_3 contact is ohmic. The two-point resistance measured between these contacts as a function of magnetic field shown exhibits positive magneto-resistance, originating from weak anti-localization of carriers in the Sb_2Te_3 nanowire induced by spin-orbit interaction. The weak anti-localization signal serves as evidence of a strong impact of spin orbit interaction on transport in the Sb_2Te_3 nanowire system. We have also measured a non-local spin valve signal in Sb_2Te_3 nanowire channels. The symmetry of this non-local spin valve (NLSV) signal is dramatically different from that of an NLSV with a channel that lacks spin-momentum locking (such as graphene). Two parallel states of the injector and detector magnetic moments give rise to different non -local voltage values, which is never observed in conventional NLSVs. This unusual symmetry is a clear signature of the spin-momentum locking in the Sb_2Te_3nanowire surface state.

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The role of nano sized defects in the Fe-Cu alloy studied by magnetic nuclear scattering

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Fe-Cu alloys are commonly used for a simulation of radiation damage of RPV steel because a neutron irradiation enhances the copper precipitate which is known as the primary reason of a RPV embrittlement. An investigation of thermal aged Fe-Cu model alloy has been a common and adequate alloy for a study of this purpose. For this purpose the selected annealing temperature is sufficiently low (753 K) compare with the solubility limit (e.g. 1023 K for Fe-1wt% Cu). The behavior of copper precipitations in the Fe-Cu alloy which is used as a simulation of radiation damage was investigated using a small angle neutron scattering (SANS). The alloy was made through a melting with pure Fe and pure Cu. Initially, the alloy is 10% cold rolled, and isothermally aged at 753 K for 20, 200 and 1800 min. The CRPs sizes, volume fractions and A-ratio of Fe-Cu alloy with aging time are obtained from the SANS data analysis. The sizes of Cu precipitates nearly constant up to aging time of 200 min and fast increased, but the volume fraction of Cu precipitates linearly increased with aging time. The investigation is focused on the behavior of copper precipitates with aging time in the 10% cold rolled Fe-Cu alloy. The objective is to identify the aging time dependence of precipitates evolution such as volume fraction and size distribution.

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Direct volumetric measurement of crystallographic texture using acoustic waves

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Crystallographic texture (i.e. preferred orientation distribution) in polycrystals has profound effects on a range of physical properties (e.g. elasticity, plasticity, magnetism and thermal expansion hence is of great industrial importance. However, cost-effective, lab-based, non-destructive measurement of bulk texture has been elusive for the existing texture measurement techniques, such as EBSD, X-ray or neutron diffraction. This talk gives an overview of the efforts towards enabling such capabilities using ultrasound. These developments are based on a general theoretical platform developed by the speaker, which demonstrates that the 3D wave speeds in a polycrystals could be approximated as a simple spherical convolution between texture and single crystal speeds, thus enabling generic inverse texture extraction. Two independent experimental implementations of the theories have been achieved: one is based on the conventional water-bath ultrasonic system, where the directional variations of polycrystals wave speeds are directly measured, to be input to the de-convolution model for texture; and the other employs the resonant ultrasound spectroscopy to measure elastic constants from a regular-shaped sample's natural frequencies, and the wave speeds are calculated from the measured elasticity. Both techniques have been used to examine a range of industrial metals, including titanium, zirconium, and stainless steels, with the results successfully verified against the well-established neutron diffraction. Utilization of such texture information, e.g. to predict macroscopic properties, is also explored.

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Local gauge invariance and spin superconductivity in materials magnetic described by the two-dimensional compass model with Heisenberg interactions

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The local spontaneous symmetry breaking is a general phenomenon in condensed matter physics. It is characterized by the fact that the action has a local symmetry but the quantum theory, instead of having a unique vacuum state which respects this symmetry, has a family of degenerate vacua that transform into each other under the action of the symmetry group. A simple example is given by a ferromagnetic model in which the act governing its microscopic dynamics is invariant under spatial rotations. A kind of local gauge invariance or spontaneous breaking of U(1) gauge symmetry is realized in nature in the phenomenon of superconductivity. We have proposed a Meissner mechanism for the spin transport in quantum spin systems that to have various applications in spintronics. Besides, we study about the behavior of the AC spin conductivity in the neighborhood of a quantum phase transition in a frustrated spin model such as the antiferromagnet in the compass lattice with single ion anisotropy at T=0. Our results show the curve of conductivity varying strongly with the behavior of the critical anisotropy Dc and J2. Katukuri *et al.* have shown that individual layers of Ba_2IrO_4 provided a good realization of the quantum compass model on the square lattice. Zhang *et al.* have used the Heisenberg model with compass interactions to study the compound Sr_2IrO_4 and pointed out that it has a close resemblance to the cuprate superconductors such as La_2CuO_4 and that many interesting phenomena common to the cuprates are also found in Sr_2IrO_4.

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Modeling of the superconductivity by using accelerating longitudinal vortices

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The report describes special kind of electromagnetic waves as accelerating longitudinal vortices. They pass through the dielectric by polarizing it and forming dipoles. But they have an extra quality that they can insert each into other. They can be nested one in the other and can form a tube. Each of them sucks in transverse direction free cross vortices as the form of dipoles too. Because the accelerating longitudinal vortices suck in from the environment free cross vortices they add some mass and energy to the tube. They also suck in the additional cross vortices from the nearest outside adjacent cylinders to the inner cylinders of the tube and accelerate themselves further in time. In this way, longitudinal vortices forming the tube are accelerating not only at a time and in a direction (from the periphery to the center). So the tube turns to a funnel. Due to the fact that accelerating longitudinal vortices suck in free cross vortices from outside to the center, the magnetic field is inserted into the electric field and the energy losses are minimal at normal room temperature. In this way, an object with superconductivity at room temperature is modeled by an electromagnetic field. The theoretical basis of the proposed tube of accelerating longitudinal vortices is described in previous articles. It consists of extending to Maxwell's main axiom (div rot E=0) to a more universal axiom (div rot E≠0). This means that it replaces even motion (constant velocity) of vector E in a closed loop with uneven motion (variable velocity) of vector E in open loop or in open vortex.

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Iron oxides/hydroxides magnetic biomaterials for application in electronics and medicine

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Nanosized biogenic iron oxides/hydroxides are promising alternatives for microetoelectronics. They have been used in "*in vivo*" experiments in NMR, for better contrast. The recently developed biotechnology was focused on acquiring new physical data for application in electronics and medicine of the biogenic material obtained due to the metabolism in laboratory conditions of iron-oxidizing bacteria from the genus *Leptothrix.* Powders and coatings on glass samples were under investigation. Analysis of the data collected show that the Fe^{2+} depending from the growth media could transformed into Fe^{3+} or $Fe^{2.5+}$ in the form of two types of oxides/(oxy)hydroxides such as lepidocrocite (ɣ-FeOOH) and magnetite (Fe_3O_4), all with nanostructured morphology. The particle's size (below 30 nm) and crystalline structure of the bioproducts were investigated by XRD, SEM, TEM, Mössbauer and Raman Spectroscopies. The structural deviations are observed in biogenic iron oxides/hydroxides by comparison with the conventional materials. The results further demonstrate that lepidocrocite is the main product of the bacteria's metabolism, both in the film and in the sediment's powder. The formation of Fe_3O_4 passes through intermediate phase – "green rust" reaction and the quantity could be controlled during the preparation. The work report results were based on SQUID measurements on the magnetic properties - M(T) of the biogenic ferroxides. Monodomain particles which are antiferromagnetic - ɣ-FeOOH and ferrimagnetic - Fe_3O_4 were received. For the needle like crystals of lepidocrocite the outer casing deviations were observed which modified the magnetic properties about 50 K. The new biogenic materials showed superparamagnetic behavior and high sensitivity to electromagnetic radiation. The biogenic tubular formation with a single-phase iron oxides/hydroxides inclusions in biogenic matrix was also investigated. Contributions for understanding the structural, magnetic and optical properties are important for fundamental research, but also some suggestions for potential applications in electronics and information technologies are proposed.

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Magnetic fluctuations in unconventional superconductors: The onset of superconducting phase transition

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We explore how antiferromagnetic spin fluctuations lead to the onset of unconventional superconducting phase transition in the Cu-based, Fe-based and heavy fermion superconductors. Realizing that electron has both the spin and the charge degrees of freedom, we will pay special attention to both the spin and the charge dynamics in line with the magnetic spin susceptibility and the optical conductivity respectively. This study helps us understand how common features (universal scaling behaviors) are revealed in the measurements of the unconventional superconductors. In this regard we first examine the observed phase diagrams of the Cu-based superconductors in light of interplay between the two degrees of freedom, based on our earlier proposed gauge theoretic approach (Ref. 1) to the slave-boson represented t-J Hamiltonian. This theory consistently provided qualitative agreements with all other measurements including optical conductivity and neutron scattering. We discuss that the onset of superconductivity is caused by the coupling of the spin (spinon) pairing order with the charge (holon) pairing order, thus revealing the interplay between the spin and the charge degrees of freedom. Further we explain the universal scaling behaviors of the linear increase of magnetic spin resonance peak energy with the antiferromagnetic coupling energy J and that of the mid-infrared peak location energy with J, for both of which the interplay of the two degrees of freedom is found to play a major role.

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Synthesis and microwave characteristic of Y and Z type hexaferrite

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We report studies on the structural, magnetic and microwave properties and magnetic phase transitions of polycrystalline Z-type $Sr_3Co_2Fe_{24}O_{41}$ and Y-type hexaferrite $Ba_{0.5}Sr_{1.5}Zn_2Al_{0.08}Fe_{11.92}O_{22}$ synthesized by sol-gel auto-combustion. The results of the ZFC and FC magnetization measurements of polycrystalline Z-type $Sr_3Co_2Fe_{24}O_{41}$ show a change in the magnetization behavior at 295 K, related to the magnetic phase transition from ferrimagnetic to transverse conical spin order. Therefore, the magneto-electric effect can be observed below 295K. The $Ba_{0.5}Sr_{1.5}Zn_2Al_{0.08}Fe_{11.92}O_{22}$ sample shows a triple loop at room temperature, due to the presence of two kinds of ferrimagnetic states. The magnetization at 50 kOe was 47 emu/g. We observed several magnetic phase transitions in the temperature ranging from 4.2 to 300 K for the $Ba_{0.5}Sr_{1.5}Zn_2Al_{0.08}Fe_{11.92}O_{22}$ sample. The magnetic phase transition from collinear ferromagnetic to proper-screw spin allows us to assume that $Ba_{0.5}Sr_{1.5}Zn_2Al_{0.08}Fe_{11.92}O_{22}$ is a multiferroic below 285 K. The microwave properties of both the Z-type and Y-type hexaferrites were studied between 1-20 GHz. A polycrystalline sample of hexaferrite was dispersed in a polymer matrix. The reflection losses of the composite samples were measured in an external magnetic field. A dramatic increase of the attenuation was observed due to the magnetic field influence on the composite samples with Z-type powder as a filler.

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To study the structural and magnetic properties of calcium titanate $CaTiO_3$ nanoparticles

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Calcium titanate with perovskite structure material is one of the best materials because of its magnetic properties. The structure and composition of calcium titanate sample is synthesized by sol-gel method. $CaTiO_3$ sample is prepared by sol-gel method exhibited the excellent magnetic properties as compare to samples prepared by hydrothermal and solid state method. The calcium titanate sample was characterized by X-ray Diffractometer, Vibrating sample magnetometer, Scanning electron microscope, Fourier transform infrared spectrometer, Raman spectra. The samples prepared by this technique were orthorhombic calcium titanate and OH functional group was detected. Due to its good magnetic properties $CaTiO_3$ used in devices, LEDs, biosensor and other electronics.

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