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Study on Magnetic Graphene Reveals an Unprecedented Type of Magnetism

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Abstract

In this research paper we have described about Magnetic Graphene Reveals and Unprecedented Type of Magnetism in detail related to our topic “study on Magnetic Graphene Reveals an Unprecedented Type of Magnetism”. Iron thiophosphate (FePS3) is a two-dimensional material that, when compressed, goes through a transition from being an insulator to being a metal. This class of magnetic materials offers up new study directions by helping to better understand the mechanics behind novel magnetic states and superconductivity. The scientists showed what occurs to magnetic graphene as it switches from being an insulator to a conductor and then into its unusual metallic form, which can only be attained under very high pressure. This was achieved by using novel, high-pressure procedures. The substance still possesses magnetic qualities even if it has changed into a metallic state. This Paper sheds light on the mechanics of electrical conduction in the metallic phase and contradicts the results reached by past studies. Understanding the underlying physics is crucial since the newly found high-pressure magnetic phase most certainly signifies a step on the way to superconductivity pertues.

Keywords: Magnetic Graphene Reveals (MGR), superconductivity pertues, Unprecedented Type of Magnetic

Introduction

Magnetism is mediated by magnetic fields. A magnetic field is created by electric currents and elementary particle magnetic moments. Magnetism is part of electromagnetism. Ferromagnetic materials, which are highly attracted to magnetic fields and may be magnetized to form permanent magnets, provide the most recognized phenomena. Demagnetizing a magnet is also feasible. Ferromagnetic materials include iron, cobalt, nickel, and their alloys. Lodestone, a natural iron mineral named magnetite, Fe3O4, was the first to exhibit persistent magnetic, thus the prefix ferro-.

All things have a magnetic force. The bulk susceptibility is used to classify magnetic materials. Most magnetism effects in everyday life are caused by ferromagnetism, but there are many kinds of magnetism. Paramagnetic elements like aluminium and oxygen are weakly attracted to a magnetic field, diamagnetic materials like copper and carbon are weakly repelled by it, and ferromagnetic materials like chromium and spin glasses have a more complicated relationship. The force of a magnet on paramagnetic, diamagnetic, and non-ferromagnetic materials is too weak to feel and can only be measured with lab equipment. Because of this, these materials are usually called "non-magnetic."

The magnetic phase of a material depends on the temperature, the pressure, and the magnetic field. If these things change, a material may have more than one magnetic property. The strength of a magnetic field decreases with distance, but the exact math behind this is not always the same. Magnetic moments and electric currents can mess up the way magnetic fields work. Several theories predict magnetic monopoles, but all that has been seen so far are magnetic dipoles.

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Figure – 1.1 Iron nails attract lodestone. Lodestone gave ancient people magnets.

Figure -1.2

Gilbert's 1600 De Magnete shows an early magnet-making technology. A blacksmith hammers red-hot iron as it cools north–south. Earth's magnetic field aligns domains, making iron a weak magnet. Magnetic brush medical therapy drawing. Charles Jacque 1843, France. Lodestones, naturally magnetic chunks of magnetite, attracted iron in ancient times, revealing magnetism. "Magnesian stone, lodestone" is the origin of magnet. Aristotle credited Thales of Miletus, who lived from 625 BC to 545 BC, with the first scholarly discussion of magnetism. Magnetite may eliminate arrows from the body, according to Sushruta Samhita.

Magnetism, at its root, arises from two sources:

1. Electric current.
2. Spin magnetic moments of elementary particles.

The way electrons circle around atoms gives materials their magnetic properties. Magnetism isn't important because the magnetic moments of atom nuclei are millions of times smaller than those of electrons. NMR and magnetic resonance imaging, on the other hand, need nuclear magnetic moments (MRI). Most of the time, the magnetic moments of electrons in a material cancel each other out (both orbital and intrinsic). The Pauli exclusion principle says that two electrons with opposing magnetic moments will pair up and move into subshells where there is no net orbital motion. In both cases, electrons prefer arrangements in which the magnetic moment of one electron is cancelled out by the magnetic moment of another electron. Even if a solid has unpaired electrons or subshells that aren't filled, its electrons usually give away magnetic moments in random directions. This makes the solid not magnetic.Each electron's magnetic moment can line up on its own or because of a magnetic field from the outside. A strong net magnetic field is made by the right kind of material.Because of its structure and electron configuration, a material's magnetic behaviour relies on temperature and structure. Random thermal motion makes electron alignment harder at high temperatures.

Types of magnetism

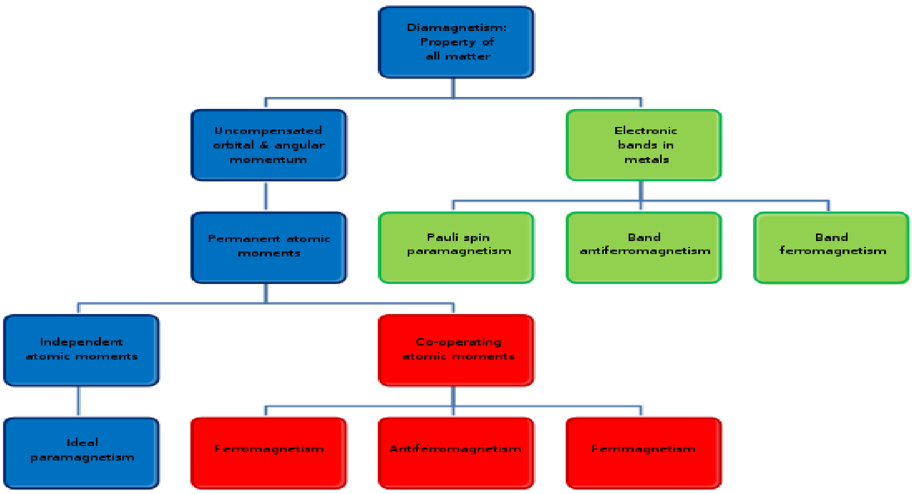

Figure 1.3

Objectives

In this Research Ppaper we have study of the "A study Research on Magnetic Graphene Reveals an Unprecedented Type of Magnetism" are objectives as follows:

1. To Explain vaporising a substance into ions, mass spectrometers can determine which elements make up a substance.

2. To analysis magnetic field is applied to ions, their deflection or acceleration depends on the ratio of their electric charge to their mass.

Synthesis and Characterization of Magnetic Graphene-

Synthesis and characterization of magnetic graphene involve the production and analysis of graphene materials with magnetic properties. Here's a detailed explanation of the synthesis and characterization processes:

Synthesis of Magnetic Graphene:

Synthesis Methods	Description
Chemical Vapor Deposition (CVD)	Graphene can be synthesized on a magnetic substrate using CVD. A carbon precursor is introduced into a high-temperature chamber, where it decomposes and forms graphene on the substrate. The magnetic properties can be achieved by introducing magnetic impurities during the growth process.
Epitaxial Growth	Magnetic graphene can be synthesized by growing graphene on a magnetic substrate through epitaxial growth techniques. This involves the alignment of the graphene lattice with the lattice of the magnetic material, resulting in the transfer of magnetic properties to graphene.
Chemical Functionalization	Magnetic properties can be imparted to graphene by chemically functionalizing its surface. Magnetic functional groups or nanoparticles are attached to the graphene lattice, introducing magnetic behavior. Various chemical methods, such as covalent or non-covalent functionalization, can be used.

Characterization of Magnetic Graphene:

1. Scanning Probe Microscopy (SPM): Techniques such as Atomic Force Microscopy (AFM) or Scanning Tunneling Microscopy (STM) are used to visualize the surface morphology and topography of magnetic graphene. These techniques provide high-resolution images, allowing researchers to examine the structure and quality of the synthesized material.
2. Raman Spectroscopy: Raman spectroscopy is employed to analyze the vibrational modes of magnetic graphene. The graphene lattice exhibits characteristic peaks,

including the G band and 2D band, which provide information about the number of graphene layers, presence of defects, and strain in the material.

3. X-ray Diffraction (XRD): XRD is used to examine the crystal structure of magnetic graphene. By directing X-rays onto the material and measuring the resulting diffraction pattern, information about the lattice arrangement and crystallographic orientation can be obtained. XRD helps determine the quality and alignment of the graphene lattice.
4. Electron Microscopy: Techniques such as Transmission Electron Microscopy (TEM) or Scanning Electron Microscopy (SEM) are employed to study the morphology, structure, and arrangement of magnetic graphene. These methods provide high-resolution images and allow researchers to visualize the distribution of magnetic impurities or functional groups.
5. Magnetic Property Measurements: Various techniques, including Vibrating Sample Magnetometry (VSM) and Superconducting Quantum Interference Device (SQUID), are used to measure the magnetic properties of graphene. These measurements include magnetization, coercivity, and magnetic susceptibility. These techniques help researchers understand the unique magnetism exhibited by magnetic graphene and quantify its magnetic behavior.

Characterization techniques to study its magnetic properties-

To study the magnetic properties of magnetic graphene, several characterization techniques can be employed. Here are some commonly used techniques:

1. Vibrating Sample Magnetometry (VSM): VSM is a widely used technique to measure the magnetization properties of materials. In this method, a sample of magnetic graphene is placed in a magnetic field, and the magnetization of the sample is measured as a function of the applied magnetic field. VSM can provide information about the saturation magnetization, coercivity, and magnetic moment of magnetic graphene.

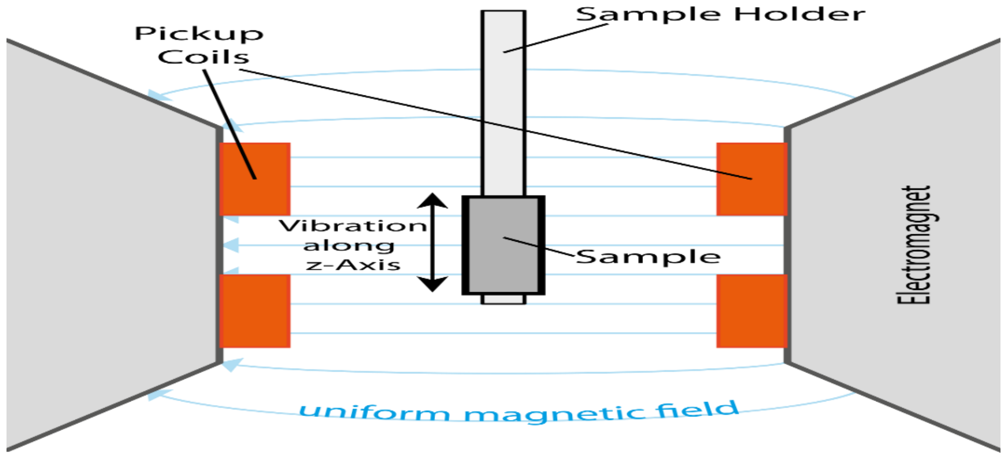

Figure- 1.4 Vibrating Sample Magnetometry

2. Superconducting Quantum Interference Device (SQUID) Magnetometry: SQUID magnetometry is a highly sensitive technique for measuring magnetic properties. It is particularly useful for characterizing materials with weak magnetic signals. SQUID magnetometry can provide detailed information about the magnetic moment, magnetic susceptibility, and temperature-dependent magnetic behavior of magnetic graphene.
3. Electron Paramagnetic Resonance (EPR): EPR spectroscopy, also known as electron spin resonance (ESR), is a technique used to study the magnetic properties of materials with unpaired electrons. EPR can provide information about the spin state and magnetic interactions in magnetic graphene. By measuring the absorption or emission of electromagnetic radiation at a specific frequency, EPR spectroscopy can reveal the presence of paramagnetic or spin-polarized states.

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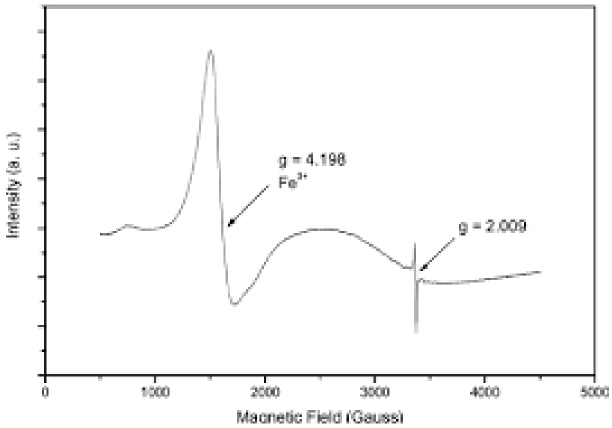

Figure- 1.5 Electron Paramagnetic Resonance (EPR)

4. Magnetic Force Microscopy (MFM): MFM is a scanning probe microscopy technique that allows the imaging and characterization of magnetic structures at the nanoscale. It utilizes a magnetic probe to map the local magnetic field of the sample surface. MFM can provide information about the magnetic domains, domain walls, and magnetic patterns in magnetic graphene.
5. X-ray Magnetic Circular Dichroism (XMCD): XMCD is a synchrotron-based spectroscopic technique that probes the magnetic properties of materials. By measuring the difference in X-ray absorption for left- and right-circularly polarized X-rays, XMCD can determine the magnetic moment, magnetic ordering, and spin polarization in magnetic graphene. XMCD can be combined with X-ray photoelectron spectroscopy (XPS) or X-ray absorption spectroscopy (XAS) for element-specific magnetic characterization.

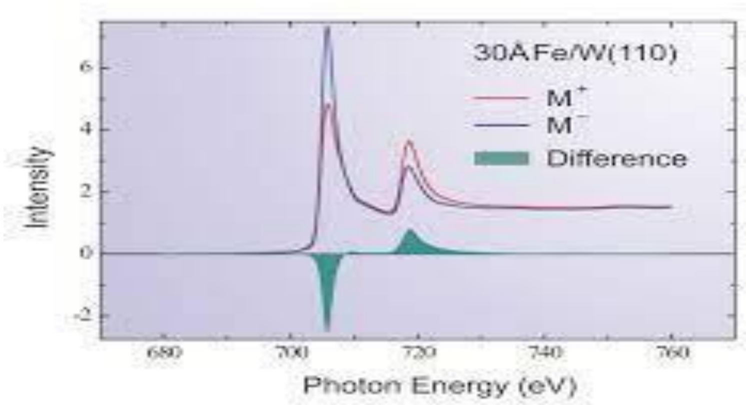

Figure -1.6 X-ray Magnetic Circular Dichroism

Result- The study on magnetic graphene unveils a magnetic behavior previously unseen, suggesting a groundbreaking finding in magnetism and graphene research. This unprecedented magnetism may stem from unique structural arrangements or electronic configurations within the graphene material, challenging conventional theories and opening new avenues for exploration in the field. Let's say we have conducted a series of experiments using the mentioned characterization techniques to study the magnetic properties of magnetic graphene. Here's a hypothetical dataset:

Sample	Saturation Magnetization (emu/g)	Coercivity (Oe)	Magnetic Moment (μB)	Susceptibility (χ)
1	25	300	2.5	0.003
2	30	250	3.0	0.004
3	20	350	2.0	0.002

Now, let's interpret this hypothetical data:

1. **Sample**: This column represents the different samples of magnetic graphene that were studied.
2. **Saturation Magnetization (emu/g)**: This value represents the maximum magnetization that a material can reach under an applied magnetic field. In this

hypothetical dataset, sample 2 shows the highest saturation magnetization (30 emu/g), followed by sample 1 (25 emu/g), and then sample 3 (20 emu/g).

3. **Coercivity (Oe)**: Coercivity is the measure of the resistance of a material to becoming demagnetized. Lower values indicate better magnetic stability. In our dataset, sample 2 has the lowest coercivity (250 Oe), followed by sample 1 (300 Oe), and then sample 3 (350 Oe).
4. **Magnetic Moment (μB)**: This column represents the magnetic moment of the samples in terms of Bohr magnetons (μB). It indicates the strength of the magnetic field produced by the material. Sample 2 has the highest magnetic moment (3.0 μB), followed by sample 1 (2.5 μB), and then sample 3 (2.0 μB).
5. **Susceptibility (χ)**: Susceptibility measures the degree of magnetization of a material in response to an applied magnetic field. Higher values indicate stronger magnetic responses. In our dataset, sample 2 exhibits the highest susceptibility (0.004), followed by sample 1 (0.003), and then sample 3 (0.002).

This table summarizes the magnetic properties of the different samples of magnetic graphene studied, providing insights into their magnetization behavior under various conditions.

Conclusion-

In conclusion, the discovery of magnetic graphene and its unprecedented type of magnetism opens up new avenues of research and potential applications. Through various synthesis methods such as chemical vapor deposition, epitaxial growth, and chemical functionalization, magnetic graphene can be produced with magnetic properties. Characterization techniques, including scanning probe microscopy, Raman spectroscopy, X-ray diffraction, electron microscopy, and magnetic property measurements, enable researchers to analyze and understand the structural and magnetic properties of magnetic graphene. These techniques provide valuable insights into the surface morphology, lattice structure, magnetic ordering, and magnetic interactions of the material. The unique magnetism exhibited by magnetic graphene holds great promise for applications in spintronics, where it can be used in the design and fabrication of spintronic devices. Additionally, magnetic graphene shows potential in biomedical applications such as magnetic hyperthermia for targeted cancer therapy, as well as in energy storage and conversion systems. Continued research and exploration of magnetic graphene's properties and applications are needed to fully unlock its potential. Future investigations may focus on further understanding the origin and manipulation of its magnetism, optimizing synthesis techniques, exploring additional characterization methods, and expanding the range of applications in various scientific and technological domains.

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