

Effect of Nanoparticles in Magnetis Properties of Tellurite Glass

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Abstract: The demand for tuneable surface plasmon (SP) of embedded magnetic nanoparticles (NPs) in rare earth doped lasing glasses is ever-growing. Glass with magnetic NPs (such as manganese, nickel, ferrite, and cobalt) are most common and very promising materials for various applications. The determination on the effect of host composition particularly the addition of increased amounts of nickel oxide (NiO) NPs on the magnetic properties of oxide glasses will be shortly reviewed. It is found out that, although different crystalline anisotropies of Ni yield different magnetic behaviors, studies on low anisotropy single-domain particles which finally contribute to the quenching or enhancement effect on the intensity emission are very much lacking.

Keywords: Nanoparticles, Tellurite glass, magnetic properties.

Among many lasing materials, heavy metal oxide (HMO) glasses such as oxide of germanium, gallium, tellurium and antimony find their importance as host matrices for good lasing candidates [1-3]. They attract great interest owing to their low melting temperature, high thermal and chemical stability, high refractive index, good infrared transmission, low phonon energy and excellent solubility for rare-earth ions [4]. Thus, the incorporation of HMOs into the glass former matrices such as tellurite glass leads to an increase in their luminescence quantum efficiency.

Tellurium dioxide (TeO₂) based glasses are widely known due to better glass stability, high nonlinear refractive index, high dielectric constants, and low melting temperatures which attract researchers [5-7]. Since TeO₂ does not form glass by itself, it belongs to the intermediate class of glass-forming oxides unless usual preparation conditions are varied or metal oxides such as Na₂O, PbO, BaO, ZnO, Nb₂O₅, WO₃ are added to it. The physical characteristic of high-purity TeO₂ glass is semitransparent with a very pale lime green color. The binary tellurite glasses have different colors, ranging from light and dark brown to black or transparent. It is depending on the kind and percentage of composition [5].

Modifier molecules usually enhance the glass formation ability (GFA) in glass formers by breaking chains of structural units. It will be causing changes in structural units and by increasing entropy. Recently tellurite glasses doped with heavy metal and rare earth oxides have received significant attention because they can favorably change density, optical and thermal properties of tellurite glasses [6]. Tellurite glasses also promising applications for up conversion of infrared to visible light, ultra broadband fiber Raman amplifiers [7] and gas sensors [8].

Modifier such as Na₂O or MgO is necessary to add to TeO₂ because the melted material quickly recrystallized. The concentration of about 10 mol% of the modifier is necessary before there is any tendency toward glass formation. The addition of Na₂O supplies

ions to complete the octets of the two cations involved to break one edge in TeO_2 . When Na^+ ions are introduced, the disrupted-edge (O) ions may coordinate around them because Na^+ or Mg^{2+} ions find positions in the holes in the network [9].

Incorporation of rare-earth into various glass oxides is a key to the optical devices development such as infrared lasers, infrared-visible converters, fibre and waveguide amplifiers for the use of optical transmission network [8, 9]. Tellurium dioxide-based glasses doped rare-earth ions has been receiving special interest due to their ability to enhance the performance of tellurite glass for their applications especially in laser and photonics. Trivalent rare-earth ions such as Neodymium are attractive as active elements in materials because of many fluorescence states to choose from 4f electron configuration where most it located in visible range. Neodymium doped all-solid-state laser sources have been identified as the most efficient laser sources for numerous applications in the fields of high-resolution spectroscopy [10]. The development of low threshold high gain host media for Nd^{3+} ion doping was encouraged by the applications in these areas. It is obvious that the enlargement of host material for Nd^{3+} ions requires optimum material properties [11]. It is because these properties make it possible to reduce excitation losses due to multiphonon relaxation. Additionally, the OH^- free tellurite glasses which are used as host material for Nd^{3+} -doped laser glasses have been a subject of increasing interest for optoelectronic applications due to their high refractive index and low phonon energies [10].

In recent years, glasses containing nanoparticles (NPs) attracting interest because the NPs as well as enhancement of the nonlinear optical properties [12]. Lately, nucleation of magnetic metal NPs inside tellurium oxide glasses were reported [13-16]. In all cases studied the presence of NPs showed superparamagnetism, high saturation field, high field irreversibility, extra anisotropy contributions or shifted loops after field cooling show amazing characteristic. These phenomena occur due to finite size and surface effects, which dominate the magnetic behavior of individual oxides. Their potential use as high density magnetic recording systems, catalysis, nanoelectronics, nano-scale optics, magnetic fluids, biomedicine and biotechnology are interesting to discover [11-13]. Generally, properties are guided by size confinement and surface effect that determine oxides applications [14].

The different kinds of magnetic NPs have been focused to synthesize since the widespread application of magnetic NPs in biotechnology, biomedical, material science, engineering, and environmental areas [15]. Nanosized particles of ferromagnetic metals such as Fe, Co, and Ni are currently attracting a lot interest due to their physical properties and potential applications like catalysts, ferrofluids, high density magnetic recording media, and medical diagnostics [16-19]. In 1956, Richardson and Milligan were the first to report magnetic susceptibility measurements as a function of temperature for NiO NPs of different sizes [17, 18]. They ascribed the observed behavior to the modified magnetic environment of the Ni^{+2} ions at the surface of the particles and the enhanced surface to volume ratio [21]. It also is paramagnetic above that temperature and has cubic structure [20].

In conclusion, it is very necessary to prepare and characterize the magnetic properties of the tellurite glass embedded with NiO nanoparticles.

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