Nanocomposites and nanomaterials

Effect of UV irradiation on magnetization dynamics and surface magnetic properties of nanomagnetite doped with noble metals

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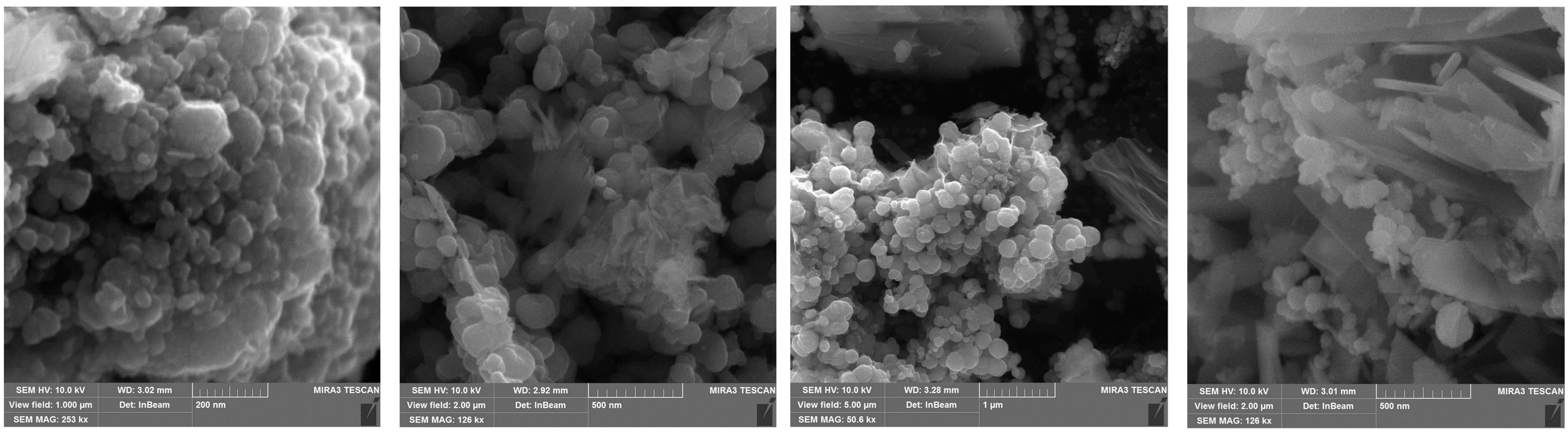
Functional nanocomposites based on such metal oxides as TiO2 , ZnO, and Fe3O4 doped with noble metals and rare earth elements (REE) can be a perspective material for the new kind of bio active photocatalysts creation. Whereas thepresence of REE in the structure of the zinc and titanium oxides enhances their photo catalytically activity [1] the inclusion of noble metal cations in the crystal lattice of iron oxides enhances their optical properties [2]. In addition effect UV irradiation on metal oxide catalysts promotes to appearance their photobactericidal activity [3]. The aim of the resent work is to compare magnetization dynamics and surface magnetic properties of as-prepared and UV irradiated nanomagnetite doped with argentum, aurum, platinum, and palladium cations. EPR spectroscopy was chosen as a main method of the investigation. The EPR experimental measurements were performed using commercial Radiopan 2547 SE/X spectrometer. According to obtained data the irradiated samples show the significant shift of EPR lines to the large-field area. Generally, such shift leads to ferrimagnetic properties reinforcement of the irradiated nanocomposites in comparison with non radiated samples. Shift intensity of EPR lines depends on the nature of noble metal dopants, but the spin quantity of the irradiated samples decreases in all cases, except Ag + -bearing sample. The magnetization intensity under UV irradiation is decreasing and became the same values for all investigated samples. The experimental data well correlate with theoretical Lorenz model fit.



a b c d

Fig. 1. SEM images of structures formed on the steel 3 surface contacted with air and water solutions with a – Pt(I) (c=5mg/dm^3); b – Pd(II) (c=5mg/dm^3), c - Ag(I) (c=10mg/dm^3), d - Au(III) (c=10mg/dm^3).

The morphology of structures is given by the SEM images in the Fig. 1. The micron sized plate-likes particles characterize the relics of the nucleation phases of Fe (II) -Fe (III) layered double hydroxides (hydroxycarbonate Green Rust) and iron oxyhydroxides (lepidocrocite with admixture of goethite). Spherical particles belong to core&shell nanocomposites based on magnetite and corresponding precious metals (silver and gold). The content of precious metals in the composite structures does not exceed 3 wt.%, that supply the optimal properties for the susceptibility of the composite particles to photocatalysis and plasmon effects. Solutions of precious metals contained from 0.5 to 20 mg/dm^3 of noble metal aquaforms. The duration of the phase formation process was 24 h.

Fig. 2 shows typical diffractograms of the nanostructures formed on the St3 surface in the presence of aurum nitrate solution (Fig. 2a) and argentum hydrochloric acid solution (Fig. 2b).

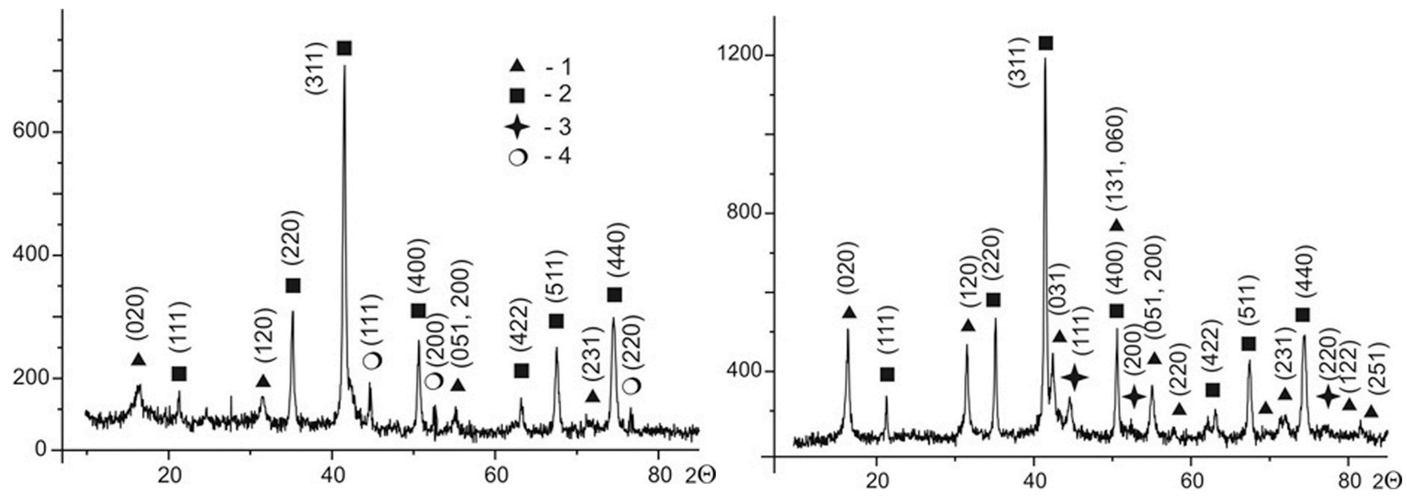


Fig. 2. XRD spectra of structures formed on the steel 3 surface contacted with air and water solutions: a - Au(III) (c=20mg/dm^3), b - Ag(I) (c=20mg/dm^3), The numbers indicate: 1 – lepidocrocite; 2 – magnetite; 3 – silver; 4 – gold.

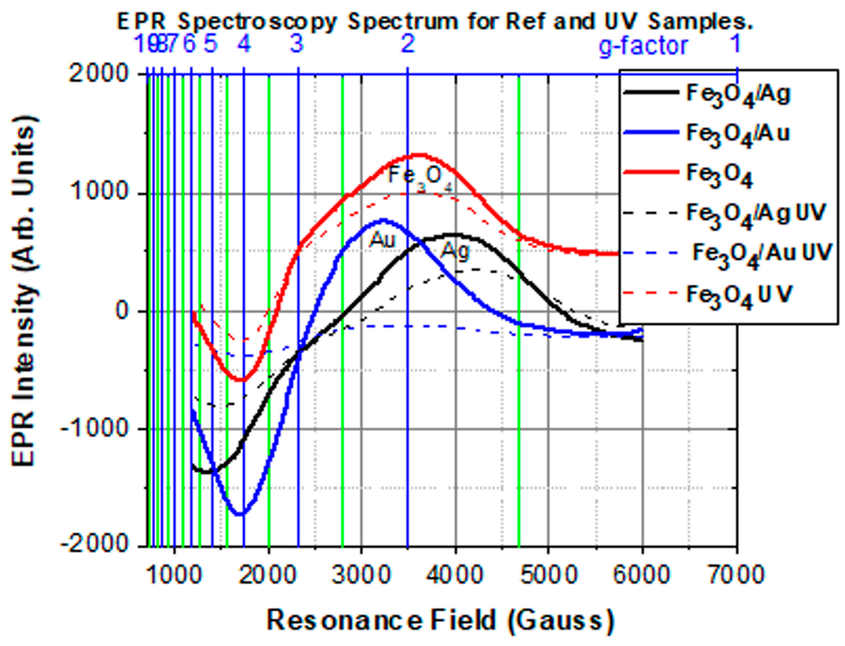


Fig. 3. Relative changes in EPR Intensity Spectra for magnetite doped with Ag(I), and Au(III)

The EPR spectroscopy was applied to determine the effect of UV irradiation (253 nm) on magnetization dynamics and surface magnetic properties of noble metal-bearing magnetite. In Fig. 3 we can see significant shift of EPR lines of the irradiated samples to large-field area accompanied by reinforcement of ferrimagnetic properties of the nanocomposites. Generally, shift intensity depends on the nature of noble metal dopants. The spin quantity of the irradiated samples decreased in all cases. The magnetization intensity under UV irradiation is also decreasing and became the same values for all investigated samples.

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