# Review on Green Synthesized Nanocomposites and Their Biological Activities

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**Abstract:** In this paper, we reviewed the present status of synthesis of nano structured materials for technological development as bimetallic, trimetallic and various organic, inorganic polymers nanocomposites in the field of nanosciences. Nanocomposites play an important role in the field of sciences, engineering and industries due to their high catalytic power, high optical, electrical and mechanical properties, which can be very useful in the field of biosensors, nano medicines and many more as social welfare factor. There are many techniques used for the preparation of nanocomposites. Among them, green method is commonly used technique for the synthesis of nanomaterials which is cost-effective, eco-friendly and less hazardous materials for the environment. Here we attempt to present an elaborate work done in the field of nanocomposites dwelling upon their advantages, challenges and future prospects.

**Keywords:** Nanocomposites • Bimetallic • Trimetallic • Green Method • Bioactivities

## Introduction

Nowadays, researchers are taking an enormous interest in the field of inorganic as well as organic polymer nanocomposites due to their unexpected hybrid characteristics, which are synthesized by heterogeneous combinations of various components as basic reactants and among the composites layered structured nano composites have been studied extensively for last decades (Sanchez et.al., 2001; Usuki et.al., 1993). Nanocomposites exhibit improved properties namely medicinal strength, moduli, thermal stability and other properties when compared with pure polymers or conventional micro and macro size composites. The enhanced properties have been achieved by synthesis of nanoscale materials via various approaches. Nanocomposites are utilized to produce optically efficient materials. Like if semiconductor nanoparticle is added with polymer, ceramic matrix materials or glass, there is enormous change in its optical property including absorption, fluorescence, and luminescence. In such kind of system, small size nanoparticles enhance optical properties while matrix material stabilized the particle size and growth (Burnside et al., 2000; Choi et.al., 2000; Byun et.al., 2001; Krikorian et.al., 2002; Xie et.al., 2002; Bhardwaj et.al., 2002).

Other applications of nanocomposite structures have resulted in transparent materials with unusually high RI, magnetic properties, and excellent mechanical properties. Nanocomposite structures provide a new method to improve the process ability and stability of materials with interesting optical properties. The applications of such composites are extremely broad, ranging from solid-state amplifier films to transparent magnets. This review focuses on recent developments in the synthesis and applications in the field of nanocomposite and nanotechnology.

**1. Green method**

This is one of the most widely applied methods for the synthesis of nanocomopsites because it is eco-friendly and it does not employ any toxic chemicals. Following steps are involved in green methods.

**(a) Preparation of Extracts**

Some amount of dried powdered plant material is addedto solvent in 500 mL round bottom flask and mixed well. The preparation of extracts is done by using magnetic heating stirrer at 70°C for 30 min. The extracts obtained is centrifuged then filtered and filtrate is kept at refrigerator for further use further (Sati et.al., 2020a).

**(b) Green synthesis of the Metal NPs by using plant extracts**

In a typical synthesis of metal NPs, plant extracts is added to the metal salt or metal oxide solution (particular molarity) with desired ratio at 80°C with constant stirring. Reduction of metal ion take place around 3 min, as monitored by UV-Vis technique. The color of the reaction mixtures gradually changes in 3 min at 80°C which indicate the formation of metal nanoparticles.The colored solution of metal NPs is then centrifuged till color completely disappear (Bartwalet.al., 2020; Sati et.al., 2020b).

**(c) Synthesis of the bimetallic or trimetallic nanocomposites**

For green synthesis of bimetallic or trimetallic nanocomposites some amount of metal saltor metal oxide is dispersed with few mL of plant extracts under continuous stirring. After 15 min, few mL (in a fixed ratio with respect to plant extracts) of other metal oxide or metal salt is added to this mixture and stirred at 80ºC for 4 h. Finally, the prepared bimetallic or trimetallic nanocomposites as separated by a magnetic separator, is washed with suitable solvent and then dried at 90ºC (Ayinde et.al., 2018; Atarod et.al., 2016; Azizi et.al., 2016; Atarod et.al., 2016).

**Table1:** Nanocomposites, Morphology and their activity

| S. No. | Name of plant (Common name) | Part Used | Type of NCs/ morphology | $\lambda_{max}$(in nm) | Characterization techniques | Activity [Ref.] |
|---|---|---|---|---|---|---|
| **1** | *Citrus paradise* (grape-fruit red) | **P** | **Ag-MgO** spherically dispersed | AgNPs at 440 NCsat 380 | UV ,TEM, XRD, FTIR ,SEM, EDX | Antibacterial (Ayinde et.al., 2018) |
| **2** | *Withania coagulans* (Paneerphool) | **L** | **Pd/RGO/ $Fe_3O_4$** | PdNPsat 263 NCsat 270 | XRD, FE-SEM, EDS, UV, VSM, TEM, FTIR, | Catalytic activity (Atarod et.al., 2016) |
| **3** | wild ginger | **EO** | **ZnO-Ag** hexagonal ZnO NPs | AgNPs at 430 NCs at 352 | UV, TEM, EDX, XRD, FTIR. | Antibacterial, antimicrobial (Azizi et.al., 2016) |
| **4** | *Euphorbia heterophylla* (Mexican) fireplant | **L** | **Ag/$TiO_2$** | AgNPs at 250–350 | UV, XRD, EDS,FESEM, FT-IR | Catalytic activity (Atarod et.al., 2016) |
| **5** | *Euphorbia wallichii* (Wallich spurge) | **L** | **Cu/RGO/ $Fe_3O_4$** Spherical | CuNPs at 550 to 580 NCs at 265 | FESEM, EDS, TEM,BET,XRD, FT-IR,elemental mapping, VSM | Catalytic activity (Atarod et.al., 2015) |
| **6** | *Melissa Officinalis* L. | **L** | **CuO/ZnO** | CuONPs At270 | SEM, Elemental mapping, EDS, TEM, | Catalytic activity (Bordbar et.al., |

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| | (Lemon balm) | | | | XRD | 2018) |
| **7** | *Euphorbia neriifolia* L (Indian Spurge) | **L** | **Pd/perlit** | Extract shows bands at 368 and 281 | TEM,EDS,XRD, FESEM,FT-IR | Catalytic activity (Maryami et.al., 2017) |
| **8** | *Ranunculus muricatus. rough-fruited buttercup* | **WP** | **Au/$TiO_2$** | - | XRD, SEM,TEM, FT-IR | Bacterial inactivation (Tahir et.al., 2016) |
| **9** | *Acalypha indica* L. (Indian Acalypha), | **L** | **Cu/sodium borosilicate** | CuNPs at558 | SEM, EDS, TEM, XRD, BET,FT-IR | Catalytic activity (Nasrollahzadeh et.al., 2018) |
| **10** | *Cuscuta reflexa* (Giant dodder) | **L** | **Cu/GO/ $MnO_2$** | CuNPs at 575 | XRD, FESEM, BET, TGA, VSM, EDS, FT-IR | Catalytic activity (Naghdi et.al., 2018) |
| **11** | *Salvadora persica* L . (Mustard tree) | **RE** | **Pd@ graphene** Pd NPs was (*fcc*) | GRO at 230, 301,$PdCl_2$at 420,SP-HRG-Pd- at 1280 | UV, XRD, TEM, FT-IR, XPS Raman | Catalytic activity (Al-Marri et.al., 2016) |
| **12** | *Citrus paradisi*. (Grapefruit) | **F** | **Silk-AuNPs** quasi-spherical, hexagonal, and triangle shapes | AuNPs at 540 | DRS, SEM, TEM, LSCM | Unique optical properties (Nolasco et.al., 2013) |
| **13** | *Euphorbia peplus* Linn | **L** | **Ag/$Fe_3O_4$** Ag/$Fe_3O_4$ spherical | AgNPs at450 | XRD, TEM, EDS, FT-IR, FE-SEM | Catalytic activity (Sajjadi et.al., 2017) |
| **14** | Mortiño *Vaccinium floribundum* (Kunth) | **B** | **Ag-Graphene** | broad peak in between 240-340 and 480-530 | FT-IR. UV, XRD, SEM, TEM | Photo catalytic activities (Vizuete et.al., 2016) |
| **15** | *Mentha longifolia* (horse mint) | **L** | **ZnO and ZnO/CuO** Spherically - distributed particles | ZnO (W) at 370 ZnO (Ext) at 370 | XRD, EDX,SEM,TGA, TEM, FT-IR, UV, DRS, BET | Anti-bacterial activity (Mohammadi et.al., 2018) |
| **16** | *Cylindrocladium floridanum* | **F** | **Nanogold-Bio-composite** Spherical | AuNPs at 540 | UV–Vis XRD, SEM, EDX, TEM | Heterogeneous catalyst (Narayanan et.al., 2011) |
| **17** | *Euphorbia helioscopia L* (sun spurge) | **L** | **Ag/RGO/ $TiO_2$** Analogous structure to $TiO_2$ | GO/$TiO_2$ visible region blue shift is observed in $TiO_2$ | UV, TEM, XRD, SEM, EDS, ICP,FT-IR | Catalytic activity (Nasrollahzadeh et.al., 2016) |
| **18** | *Orchis mascula L.* (early spring orchis) | **L** | **Cu/egg shell, $Fe_3O_4$/ eggshell** spherical shaped (size 5-15 nm) | CuNPs at575 | UV, DTA-TGA,FT-IR, FE-SEM, EDS, XRD, BET, VSM | Catalytic activity (Nasrollahzadeh et.al., 2016) |
| **19** | *Pulicaria glutinosa* | | **Graphene/ Ag** AgNPs seems FCC | GRO at 230 and 301, AgNPs at 420 | UV, XRD, EDX | Substrates for SERS activities (Al-Marri et.al., 2015) |

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| **20** | *Lycopersicon esculentum* (Tomato) | **F** | **Biocidal Silver-Activated Charcoal** exfoliated structure almost-transparent single layer GO | AgNPs at 410 NCs at 410 | XRD, SEM, UV | antimicrobial activity, water purification (Arputha et.al., 2013) |

**Abbreviation (**NPs – Nanoparticles; NCs – Nanocomposites; P- Peels; EO- Essential Oil; L- Leaf; WP- Whole Plant; B- Berries, RE – Root Extract; F- Fungus; RGO- Reduce Grapheme Oxide, FCC- Face Centered Cubic Cell)

## Conclusion

Nanocomposites are one of the most important tools in the field of science, engineering, and industry also. Nanocomposites are one step advance than metallic nanoparticles because nanocomposites are like a junction between two or more nanoparticles and they have highly versatile property when compared to nanoparticles. Nanocomposites are very useful for sunlight-induced degradation of organic pollutants and wastewater treatment. Although a variety of photo catalysts have been designed toward this goal, various methods have been used in formation of bimetallic or trimetallic and various organic and inorganic polymers nanocomposites. Most of these methods are still in progressing stage.In this review paper it is concluded that nanocomposites synthesized by green method are excellent in differentbiological activitieswith high catalytic power.

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