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Eco-friendly Synthesis, Spectral Characterization, Particle image and Size Analysis of Cerium Oxide Nanoparticles Mediated By Waste Chow Chow Vegetable Seed Kernel Aqueous Extract

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Abstract:

A novel approach for the utilization of fruit waste is attempted in the present investigation. *Chayote (Chow chow)* seed aqueous extract was utilized for green synthesis of cerium oxide nanoparticles (CeONPs). The phytoconstituentsin the seed acted as reducing and stabilizing agent for CeONPs formation. UV-Vis, FT-IR, FL, DLS and SEM, analysis were used to characterize the green synthesized CeONPs.UV-vis spectra showed characteristic spectra at 278 nm; DLS and SEM confirmed the crystalline nature. FT-IR revealed functionalgroups like alcohol or phenols, carboxylic acids, ketones, amines, aromatic amines, aliphatic amines,alkyl halides and alkynes which were responsible for CeONP formation. The nanoparticles showed more CV study of cerium oxide nanoparticle. *Chayote (Chow chow)* seed waste can be successfully utilized for cerium nanoparticlesformation which can be therapeutically useful and effective.

Keywords**: Eco-friendly synthesis, CeONPs, *Chayote (Chow chow)* seed, Spectral characterization and CV study.**

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I. INTRODUCTION

In science and technology, one among the rapidly developing concepts in the newest years is nano-biotechnology, which has fetched terrific improvement of the nanomaterial which comprises distinctive physicochemical properties has the potential to develop new systems, structures, devices, and nano platforms with impending bids in extensive variety of disciplines [1, 2]. Nano sized materials are particles that are in size of 1-100nm, and they are exact minor particles with enhanced chemical stability, nonlinear optical performance,thermal conductivityand catalytic reactivity, due to their large surface area-to-volume ratio [3]. This eminence has engrossed many investigators to pinpoint novel techniques for their synthesis. However predictable techniques use less stint to synthesize bulk quantity of metal oxide nanoparticles, they necessitate venomous chemicals like defensive agents to conserve constancy, which leads to toxicity in the environment. Custody this in notice, plant biotechnology mediated byutilizingvarious parts of plants is rising as an environmental-friendly, harmless, and innocuous choice, subsequently plant extract-mediated biosynthesis of nanoparticles is parsimoniously beneficial and proposals natural capping negotiators in the form of proteins [4]. To standardize chemical toxicity in the surroundings, biosynthesis of various metal oxide(MONPs) and metal nanoparticles (MNPs) through plant parts extraction is utilized, which is a peripheral technique for regulating chemical synthesis, and it permits a divergentsilhouette and size of nanoparticles with a scrupulous synthesis [5]. For biomedical

applications, heightening in biodegradable, functionalized, and biocompatible nanomaterials is being persisted a fabulouscheerful area for research. Until now, amidabundant other biomedical tenders [6–9] well examined are paramagnetic nanoparticles [10,11], quantum dots (QDs) [6, 12], nanoshells [13], and carbon nanotubes (CNTs) [14, 15]. Cerium oxide CeO_2 (CeO_2NPs) crystal lattice, comprises of a cerium central enveloped by an oxygen lattice. These particles have an thought-provoking feature, cohabitation of Ce^{3+} and Ce^{4+} ions and the capability of oxygen vacancies formation on their superficial, which assists them to intermingle with and restrain free radicals. In such way these nanoparticles can pass several cycles of reactions with free radicals and thus regenerate themselves in each cycle [16, 17]. This is a matchless feature manufacture CeO_2NPs beneficial in comparison with the other nanoparticles. Also, compared with other rare earth elements(inner transition elements), CeO_2NPs have a high hydrogen-absorbing ability, such that reactions with H_2, O_2, or H_2O occur further enthusiastically, which may interpretation for its regenerative capability as a catalyst [18]. As such, they spectacle antioxidant/antiradical activity [19, 20] that invigorated studies of pharmacological prospective of these nanoparticles, as well as their biomedical tenders [21-23]. Some studies obligate shown defensive effect of the CeO_2NPs towards oxidant-mediated apoptosis [24,25]. However, in certain studies CeO_2NPs prompted oxidative hassle either in vitro or in vivo [26, 27]. Conferring to the structural conformation and morphology, nanomaterials have been alienated into synthesisednano-materials and nano-dispersions. Exceedinglydivided macromolecules are dendrimers with the magnitudes in the nanometer scale. In the metal-based materials, the principalconstituent for these particles is metal, where the nanomaterialsencompassed AgNPs, AuNPs, metal oxides like TiO_2NPs, and finally meticulouslybursting semiconductors such as quantum dots. The morphology of carbon-based nano-materials is tubes, hollow spheres, or ellipsoids. The carbon nanomaterials that are spherical and ellipsoidal are denoted as fullerenes and cylindrical ones are called as nanotubes.

II. MATERIAL AND METHODS

2.1. Collection of Sample

The seed of *Chayote (Chow chow)*(**Figure:1**)were collected from my home kitchen waste. The seeds were manually separated after breaking seed kernel, shade dried at room temperature and homogenised to fine powder and stored in air tight bottles.

2.2. Chemicals, Solvents and Starting Materials

All the metal salts and de-ionized water, Whatmann1≠and Whatmann 41≠ filter papers, Ethyl alcohol, sodium hydroxide pellets, Hydrochloric acids, sulphuric acid and other chemicals were purchased from Merck (India) Ltd. All chemicals were used without further purification.

2.3 Instruments and equipment

Electric oven, Magnetic stirrer (REMI 2 MLH), E-1 portable TDS & EC meter, pH-009(I)A pen type pH meter, sterilized 250ml separating funnels, sterilized conical flasks, sterilized 400ml beakers, watch glasses, 7'' funnels, glass rods, and 10ml measuring cylinders,

2.4. Preparation of *Chayote (Chow chow)* seedExtract

5 grams of powdered *Chayote (Chow chow)* seedwith 50 mL of double-distilled water (DDW) taken in the 250 mL round bottomed flask, water condenser fitted and fix the running tap water then heated for 20 min at 80^O C. Then the extract was filtered with Whatmann 1≠ filter paper. The filtrate was used to the further green synthesis of process

Figure:1 Image of Image of sliced Chow chowvegitables

2.5 Synthesis of Cerium oxide nanoparticles (CeONPs)

Figure:2 Green synthesis of cerium nanopartilces by *Chayote (Chow chow)* seed

Cerium nanoparticle was synthesised from Cerium ammonium sulphate (M.F: $(NH_4)_4$ $(SO_4)_2$. $Ce(SO_4)_2$, MW: 632.55 g/mol) using *Chayote (Chow chow)* seedExtract. To achieve this purpose, 100 mL of saturated solution of Cerium ammonium sulphate is steadily mixed with 10mL of *Chayote (Chow chow)* seedextract, immediately obtained milky colour colloidal suspensions [93]. The colour of the solution is turn in Pale golden-yellowish solution turn to milky white (**Fig:2**). Further, obtained suspension filtered with wattman 1≠ filer paper. The precipitate was carefully washed three times with distilled water to remove unboundedcomponents. The obtained powder assumed as CeNPs was incubated at ~100 °C until the water evaporated completely. Finally, CeNPs were thoroughly characterized

III.RESULT AND DISCUSSION

3.1 UV spectral study

UV-visible spectroscopy is one of the most widely used techniques for structural characterization of CeNPs. Figure 3.shows the UV-Vis spectra of obtained CeNPs mediated by Chayote (Chow chow) seed powder extract. SPR band was broad, indicating poly-dispersed nanoparticles. SPR band around 333 nm broadened and slightly moved to the long wavelength region indicating the presence and formation of CeNPs. The optical absorption spectra of metal NPs were dominated by SPR, which shift to longer wavelengths with increasing particle size. The position and shape of plasmon absorption of cobalt particles were strongly dependent on the particle size, dielectric medium and surface-adsorbed species. The surface Plasmon absorption of CeNPs has the short wavelength band in the visible region around 278 nm due to the transverse electronic oscillation

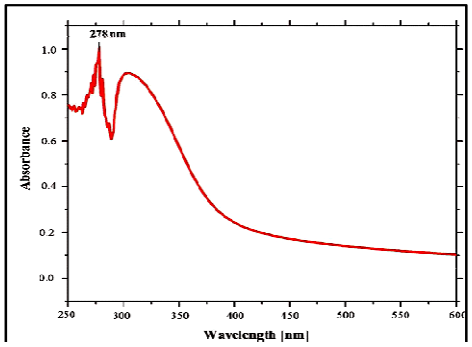


Figure:3 UV spectrum of Cerium nanoparticles by Chow-chow (*Sechiumedule*) seed extract

3.2 FTIR spectral Analysis

The FTIR analysis was further performed to determine the phyto-constituent containing functional groups involved in synthesizing Ce_4O_8 nanoparticles as reducing and capping agents. **Figure 4,**The results of CeONPs FTIR spectrum demonstrated that the frequency of 3430 cm^{-1} at thevery broad peak represent the various stretching

frequencies are merged to appeared it, this peak had been screened out -O-H group in alcohols and acids, the peak of 2057cm^{-1} have demonstrate CH_3, CH_2&CH,The sharp stretching frequency of 1642 cm^{-1} have represented by -C=O- group contain functional groups of aldehyde, acid and its derivatives. -N-H group in amide, -C=N nitrile, -C-H aromatic stretching and aldehydic –CH stretching frequencies, strong peak of 1072 cm^{-1}-C-H bending in gem dimethyl,the frequency of 570 cm^{-1} have shown inCe-O stretching vibrations. These results suggest that many biologically active phyto-molecules are left adsorbed on the surface of the Ce_4O_8 nanoparticles

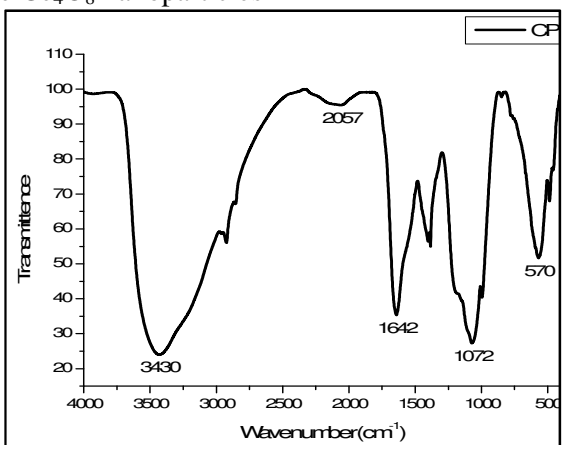


Figure:4 FTIR spectrum of cerium nanoparticles mediated by Chow-chow (*Sechiumedule*) seed extract

3.3Fluorescence spectra

The fluorescence emission spectrum has been shown an obvious peak at 725.50 nm in CeONPs sample, shows no trend in neither the Stern-Volmer quenching plot nor the direct fluorescence method (**Figure 5**). Overall, even in the presence of CeONPs nanoparticles.

3.4. DLS analysis

DLS is often interpreted to as a scattering of quasi-elastic light. It accomplishes the part of size dissemination and agglomeration of selective NPs. This process is quite delicate, hurried and it can estimate the mean size of a particle on both macro and nano scale. The speed of the DLS technique is based on particle size. Small particles in suspension endure arbitrary thermal motion notorious as Brownian motion. This random motion is modeled by the Stokes-Einstein equation. Below the equation is given in the form most often used for particle size analysis. The DLS analysis of green synthesized cobalt nanoparticle to shown the average size of the nanoparticle is 104.08 nm. This result also shown in some of the nanoparticle having more than 100 nm, this is due to growth of the nanoparticle and aggregation of the two is more nanoparticles.

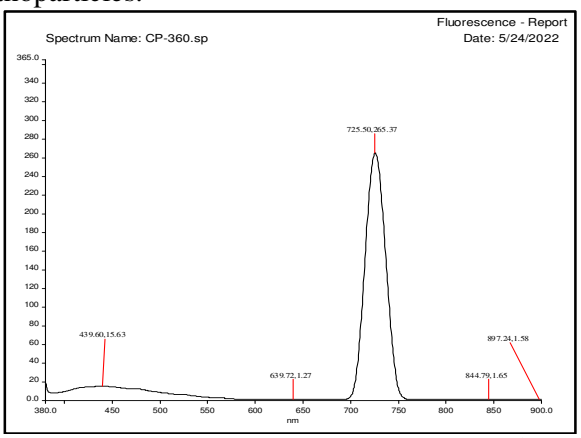


Figure:5 Fluorescence spectra of CeONPS by Chow-chow (*Sechiumedule*) seed extract

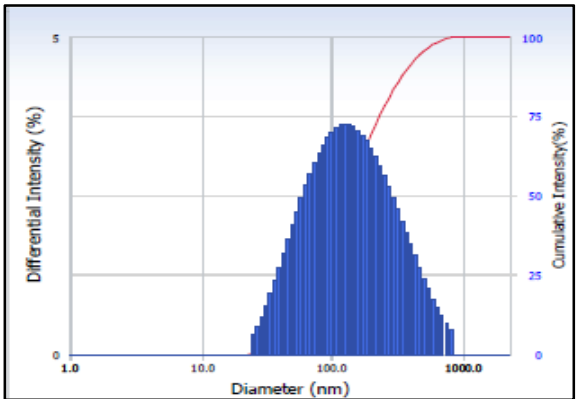


Figure:6, DLS images of CeONPS by Chow-chow (*Sechiumedule*) seed extract

3.5 SEM analysis

The morphology determined by SEM analysis of green synthesized Ce_3O_4 nanoparticle by Chow-chow (*Sechiumedule*) seed extract has shown Figure; 7a, 7b and 7c. It can be seen from SEM image that Ce_3O_4NPs are agglomerated and not well formed. One can vibrantly see well distinct nanoparticles with discriminate shapes. Explicitly, SEM image for Ce_3O_4NPs reveal distinguishable rhomboid shaped nanoparticles, elongated nanorods and highly agglomerated nanoparticles, Ce_3O_4 nanoparticles become well-formed reveling distinct

shapes. To identify chemical elements and purity of synthesized samples Figure 7a shown in 2 µm, 7b shown in 2 µm, Figure 7c has been shown 1 µm

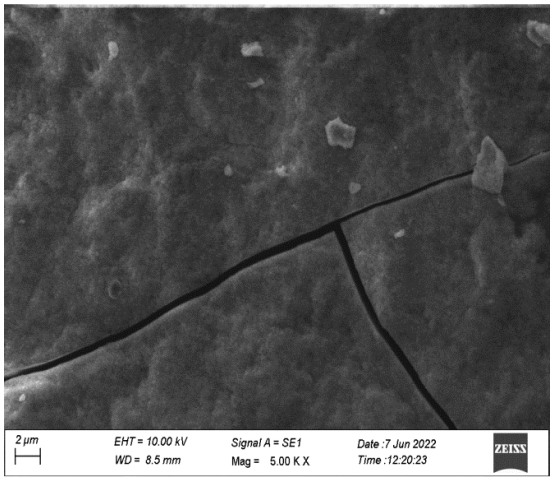


Fig. 7a SEM Image of cerium nanoparticles by **Chow-chow (*Sechiumedule*) seed extract**

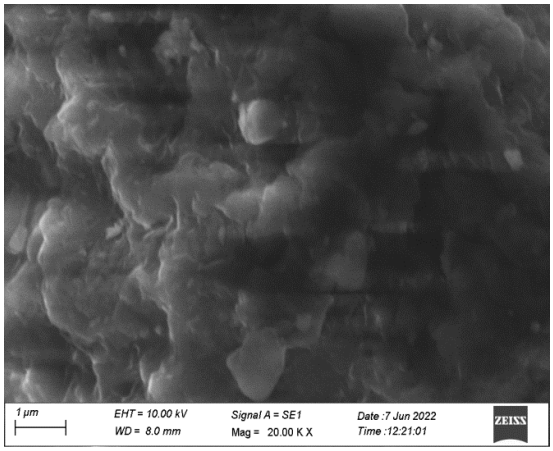


Fig. 7b SEM Image of cerium nanoparticles by **Chow-chow (*Sechiumedule*) seed extract**

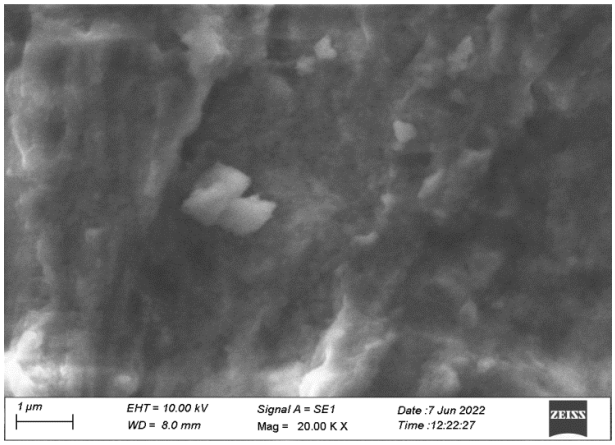


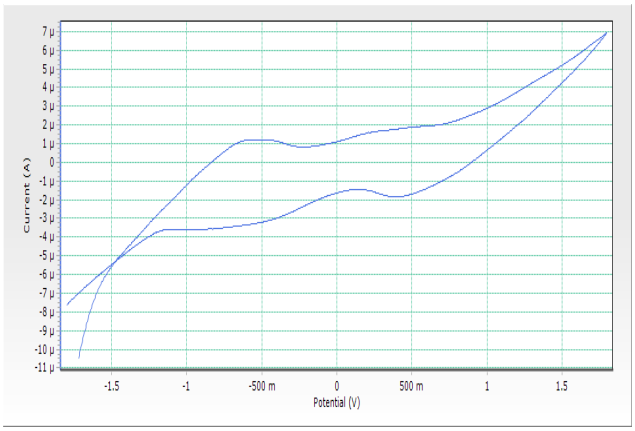
Fig. 7c SEM Image of cerium nanoparticles by **Chow-chow (*Sechiumedule*) seed extract**

3.6. Cyclic voltammetry and discharge curve

The shape of the cyclic voltammetry curves is an ideal rectangular shape observed at 10 mV/s. Further increasing the scan rate the observed pattern of the CV curve is altered and it confirms the pseudo capacitive nature of the material**.**

Figure:8 cyclic voltammetry study of CeONPs by Chow-chow (*Sechiumedule*) seed extract

The specific capacitance (SC) values of manganese ferriteelectrode can be estimated by using the formula



$$Cs = Q / m\Delta V$$

Electrochemical measurements were performed in 0.2 tetra butyl ammonium perchlorate with a standard three electrode configuration consisting of a sample (working electrode), an Ag/ AgCl (reference electrode) and a high platinum wire (counter electrode). The scan rate increased in the range from 10 mV/s to 100mV/s and its corresponding specific capacitance values depicted in Fig.8 Further, the specific capacitance values of 290.4 F/g observed in the scan rate of 10 mV/s for the sample annealed at 700°C. The intention for high specific capacitance at low scan rate is detected in the current study recommended that the ionic diffusion takes place both inner and outer surfaces. The higher specific capacitance values observed in the present study confirm the good crystalinity of the cobaltnanoparticles.

CONCLUSIONS

The present study describe the green synthesis and characterization) of cerium nanoparticles formed by

home waste of mango seed kernel extract. Each and every day, many tones of chow chowvegitables are used in the hotels and home uses, chow chow is a very familiar and childrens liking vegitable. but seed of chow chow was waste one, this seeds are contain various natural products like alkaloids, teripnaoids, steroids, flavonoids, spannin, oils, fats..etc This compounds are improved the drug delivery, colouring compounds and discovery of perfumery products.The green synthesized cerium nanoparticles are subjected to Dynamic light scattering analysis to measure the particle size.Scanning electron microscope analysis of cerium nanoparticles have shown cerium oxide nanoparticles shape and various magnifications. Cyclic voltammetry analysis to measure the electrical property of the green synthesized cerium oxide nanoparticles by chow chowvegitables seed extract.

REFERENCES

[1] H. Mirzaei and M. Darroudi "Zinc oxide nanoparticles: biological synthesis and biomedical applications" Ceramics International, 43(1), 907–914,2017.

[2] S. C. C. Arruda, A. L. D. Silva, R. M. Galazzi, R. A. Azevedo, and M. A.Z. Arruda, "Nanoparticles applied to plant science: a review," *Talanta*,131, 693–705, 2015.

[3] H. Agarwal, S. V. Kumar, and S. Rajeshkumar,"A review on green synthesis of zinc oxide nanoparticles– An eco-friendly approach" R*source- Efficient Technologies*., 3, 4 (2017) 406–413.

[4] H. A. Salam, R. Sivaraj, and R. Venckatesh, "Green synthesis and characterization of zinc oxide nanoparticles from Ocimumbasilicum L. var. purpurascensBenth.-Lamiaceae leaf extract" *Materials Letters*, vol. 131, 16–18, 2014.

[5] P. T. Anastas and J. C. Warner, *Green Chemistry: Theory and Practice*, Oxford University Press, Oxford, UK, 2000.

[6] W. Cai and X. Chen, "Nanoplatforms for targeted molecular imaging in living subjects," *Small*., 3. 11, 1840–1854, 2007.

[7] H. Hong, Y. Zhang, J. Sun, and W. Cai,"Molecular imaging and therapy of cancer with radiolabeled nanoparticles" *Nano Today*., 4.5 399–413, 2009.

[8] Y. Zhang, H. Hong, D. V. Myklejord, and W. Cai, "Molecular imaging with SERS-active nanoparticles"*Small*., 7.23,3261–3269, 2011.

[9] M. V. Yigit and Z. Medarova"*In vivo* and *ex vivo* applications of gold nanoparticles for biomedical SERS imaging" *Am J Nu Med and MoleImag*, 2.2, 232–24, 2012.

[10] J. E. Hutchison., Green Nanoscience: "A Proactive Approach to Advancing..Implications of Nanotechnology"*ACS Nano*., 2.3 395–402,2008.

[11] W. Cai, A. R. Hsu, Z.-B. Li, and X. Chen, Are quantum dots ready for in vivo imaging in human subjects?"*Nanoscale Research Letters*, vol. 2, 6. 265–281, 2007.

[12] W. Cai and H. Hong, In a "nutshell": intrinsically radiolabeled quantum dots "In a *American Journal of Nuclear Medicine and Molecular Imaging*, 2, 2, 136–140, 2012.

[13] L. R. Hirsch, A. M. Gobin, A. R. Lowery et al., "Metal nanoshells," *Annals of Biomedical Engineering*, 34.1, 15–22, 2006.

[14] L. Lacerda, A. Bianco, M. Prato, and K. Kostarelos, "Carbon Nanotubes as Nanomedicines: From Toxicology to Pharmacology" *Adv Drug Deliv Rev*, 58, 14,1460–1470, 2006.

[15] H. Hong, T. Gao, and W. Cai, "Molecular imaging with single-walled carbon nanotubes" *Nano Today*, 4, 3, 252–261, 2009.

[16] H.Wei, N.Insin, J.Lee, H.Han, J.M.Cordero, W.Liu, M.G.Bawendi,"Compact Zwitterion-Coated Iron Oxide Nanoparticles for Biological Applications". Nano Lett. 12, 22–25, 2012.

[17] G.H.Woehrle, L.O.Brown, J.E.Hutchison,"Thiol-functionalized, 1.5nm gold nanoparticles through ligand exchange reactions: Scope and mechanism of ligand exchange". J. Am. Chem. Soc., 127, 2172–2183,2005.

[18] C.Tso, C.Zhung, Y.Shih, Y.Tseng, S.Wu, R.Doong, "Stability of metal oxide nanoparticles in aqueous solutions" Water Sci. Technol. 61, 127–133,2010.

[19] A.A.Keller, H.Wang, D.Zhou, H.S.Lenihan, G.Cherr, B.J.Cardinale, R.Miller, Z.Ji,"Stability and aggregation of metal oxide nanoparticles in natural aqueous matrices" Environ. Sci. Technol., 44, 1962–1967, 2010.

[20] O.Oriekhova, S.Stoll, "Stability of uncoated and fulvic acids coated manufactured CeO2 nanoparticles in various conditions: From ultrapure to natural Lake Geneva waters". Sci. Total Environ, 562, 327–334, 2016.

[21] Y.Zhang, Y.Chen, P.Westerhoff, K.Hristovski, J.C.Crittenden,"Stability of commercial metal oxide nanoparticles in water". Water Res. 42, 2204–2212,2008.

[22] A.Luchini, G.D'Errico, S.Leone, Z.Vaezi, A.Bortolotti, L.Stella,G.Vitiello, L.Paduano, "Structural organization of lipid-functionalized-Au nanoparticles". Colloids Surf. B 168, 2–9, 2018.

[23] M.Vaccaro, G.Mangiapia, L.Paduano, E.Gionalino, A.Accardo, D.Tesauro, G.Morelli, "Structural and relaxometric characterization of peptide aggregates containing gadolinium complexes as potential selective contrast agents in MRI" Chem. Phys. Chem., 8, 2526–2538, 2007.

[24] A.Luchini, C.Irace, R.Santamaria, D.Montesarchio, R.K.Heenan,N.Szekely, A.Flori, L.Menichetti, L.Paduano, "Phosphocholine-decorated superparamagnetic iron oxide nanoparticles: Defining the structure and probing in vivo applications". Nanoscale., 8, 10078–10086,2016.

[25] M.Perfetti, N.Gallucci, I.Russo Krauss, A.Radulescu, S.Pasini, O.Holderer, G.D'Errico, G.Vitiello, G.O.Bianchetti, L.Paduano,"Revealing the aggregation mechanism, structure, and internal dynamic of poly (vinyl alcohol) microgel prepared through liquid-liquid phase separation". Macromolecules, 53, 852–861, 2020.

[26] J.E.Spanier, R.D.Robinson, F.Zhang, S.W.Chan, I.P.Herman, "Size-dependent properties of CeO2-y nanoparticles as studied by Raman scattering". Phys. Rev. B, 64, 245407/1–8, 2001.

27. Lee, Y.; He, G.; Akey, A.J.; Si, R.; Flytzani-Stephanopoulos, M.; Herman, I.P. Raman analysis of mode softening in nanoparticles CeO2-_ and Au-CeO2-_ during CO oxidation. J. Am. Chem. Soc. 2011, 133, 12952–12955.

[1] J. Padhye, V. Firoiu, and D. Towsley, "A stochastic model of TCP Reno congestion avoidance and control," Univ. of Massachusetts, Amherst, MA, CMPSCI Tech. Rep. 99-02, 1999.

[2] *Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification*, IEEE Std. 802.11, 1997.

