Synthesis of Iron oxide Nanoparticles in a premixed propane-air premixed flame "ETH-NPC-2018(12)"

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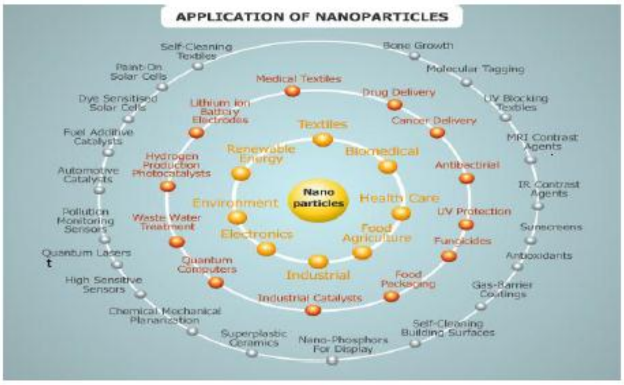
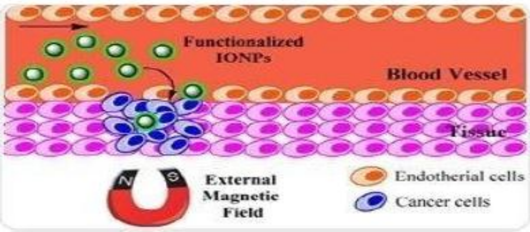
Abstract

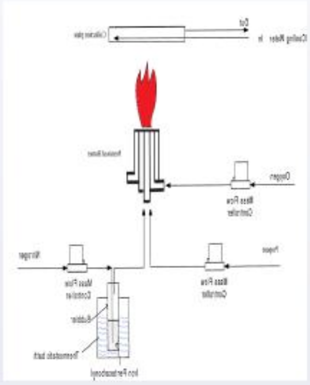
Combustion synthesis is the simplest and most economic method for nanoparticle production. Diffusion flames are most commonly deployed by the scientific community for producing nanoparticles from flames. However, premixed flame is promising one step process that provide better control on flame configuration and its characteristics. The project focuses on synthesis functional iron oxide nanoparticles that can be used for different biomedical and industrial applications. The morphology and characteristics of produced nanoparticles are carried out by using TEM (Transmission Electron Microscope), XRD. The samples are collected in dilution tunnel with cascade impactor. This work to undertaken to understand and establish the effects of precursor concentration, temperature, and residence time in premixed flames on iron-oxide to achieve desired end particle morphology, phase and composition and properties. There are number of challenges associated with the combustion synthesis of nanoparticles to achieve good control of particle size, size distribution, phase and composition.

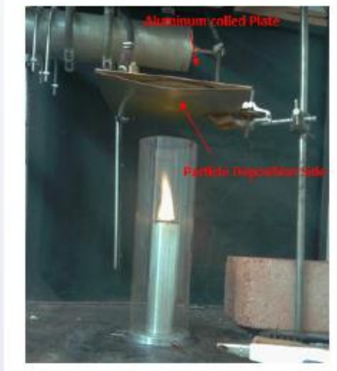


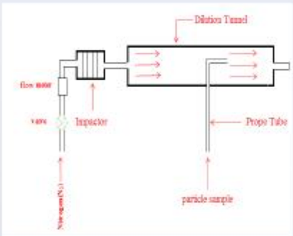


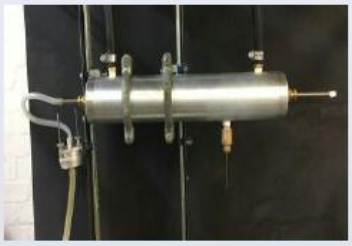
In recent years, it was indicated by researches that both maghemite and magnetite are potentially used in biomedicine application. Magnetite is biocompatible and non-toxic to human and therefore made revolutionize in medicine regarding the cancer treatment. Also, magnetite is highly response to magnetic field. Thus, MIONPs are extensively used in many fields of biomedical applications such as cancer treatment, tissue repair, cell labeling, and magnetic cell sorting. To kill cancer cell, exposition of cancers tissues to an altering magnetic field with functionalized IONPs which embedded around a tumor site and placed within an oscillating magnetic field. IONPs are high response to an external magnetic field. When magnetic particles are subjected to a variable magnetic field, some heat is generated. Resulting in heat up a temperature that lead to destroy the cancer cells at temperature higher than 43°C.

Experimental Methodology



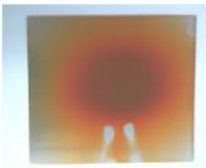


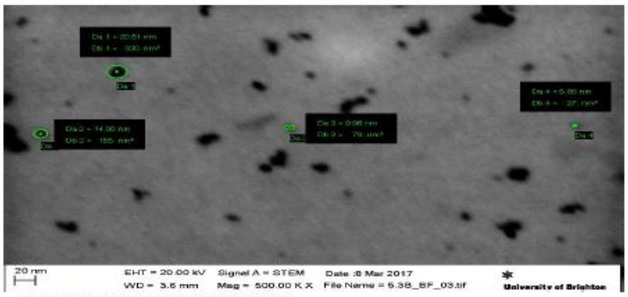




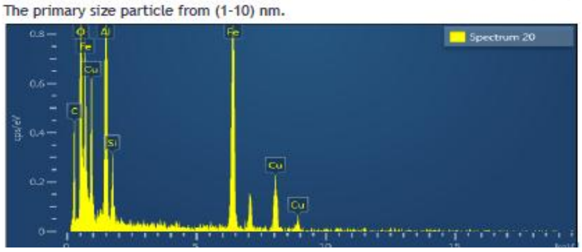
Experimental methodology is set up with an equivalence ratio at 1.0 and running using premixed C3H8/Air/N2/doped with iron pentacarbonly Fe(CO)5. In flame synthesis the fuel is mixed with precursor Fe(CO)5 that carrier by gas (Nitrogen).Then, the mixture is injected into temperature flame. The chemical reaction mechanism and particle growth mechanisms take over leading to nucleation, growth and further evolution of nanoparticles. High-temperature flame processes for the production of iron oxide nanoparticle. Iron oxide particles were sampled thermophoretically from the flame at a height of approximately 14 cm from the tip flame. In the present work, a compactor in a series (A-D) plates was made from Aluminum has been used to collect the nanoparticle. The compactor is connect by plastic tube with dilution tunnel. Developed by using a premixed propane-air flame generator set integrated with dilution tunnel and nanoparticles collection micro grid. To characterize phase analysis and crystallite size an aluminum cooled plate was used to collect the powered for XRD characterization. Energy dispersive X-ray spectroscopy (EDX) was performed on the sample to obtain compositional information and identify any potential impurities.

Results and Discussion





The primary size particle from (1-10) nm.



Conclusion

- A new premixed flame system has been developed to generate, capture and analyse different nanoparticles from premixed flame.
- The morphology of nanoparticles and particles size show the particle produced in narrow size distribution from (1-30 nm).
- The iron oxide nanoparticle produced in flame synthesis is high -purity powders, small particle size, high specific surface area, and controlled particle size distribution.
- EDS analysis of the sample shows that synthesis of the particles from premixed flame produces pure Fe2O3 nanoparticles with very little other impurities present.
- XRD diffraction of the produced powder shows mainly iron oxide nanoparticle properties by synthesizing less hematite as compared to magnetite.
- At higher precursor loading rate, a significant impact on the particle growth, inception and formation of primary particles occur both in the small spherical balls and large clouds.

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