

Examining Nanoparticles with Different Laser wavelengths

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Mechanical Engineering

by

LAKSHMANA VIJAYAN (Reg.No.39150071)

T LOKESH (Reg. No.39150074),



DEPARTMENT OF MECHANICAL ENGINEERING
SCHOOL OF MECHANICAL ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

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INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with "A" grade by NAAC
Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai-600119
www.sathyabama.ac.in



DEPARTMENT OF MECHANICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of M LAKSHMANA VIJAYAN (Reg.No.39150071), T LOKESH (Reg. No.39150074), who have done the Project entitled **“Examining Nanoparticles with Different Laser wavelengths in Liquid Environment”** Under our supervision from JULY 2022 to APRIL 2023.

INTERNAL GUIDE

Dr. G. SENTHIL KUMAR, ME., PhD.,

Head of the Department

Dr. G. ARUN KUMAR M.E., Ph.D.,

Submitted for Vivavoce Examination held on 26.4.2023

Internal Examiner

External Examiner

DECLARATION

We M LAKSHMANA VIJAYAN (Reg.No.39150071), T LOKESH (Reg. No.39150074), hereby declare that the Project Report entitled“ **Examining Nanoparticles with Different Laser wavelengths in Liquid Environment.**” done by me under the guidance of **Dr. G.SENTHIL KUMAR, ME.,PhD.**, is submitted in partial fulfilment of the requirements for the award of bachelor of Engineering in Mechanical Engineering.



DATE: 18.4.2023

PLACE: CHENNAI

SIGNATURE OF THE CANDIDATE

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CONTENTS

S.NO	TITLE	PAGE NO
1	ACKNOWLEDGEMENT	IV
2	ABSTRACT	VI
3	CHAPTER – 1 INTRODUCTION	1
4	CHAPTER – 2 LITERATURE SURVEY	3
5	CHAPTER – 3 AIM AND SCOPE	17
	3.1 AIM	17
	3.2 EXISTING WORK	17
	3.3 SCOPE	17
6	CHAPTER – 4 MATERIALS AND METHODOLOGY	18
	4.1 FORMATION OF NANOPARTICLE	18
	4.2 STUDY OF LASER HEATING EXPERIMENT	19
	4.2.1 SETUP FOR THE EXPERIMENT AND HEATING METHOD	19
	4.2.2 HEATING WITH 488nm PURPLE LIGHT LASER	19
	4.2.3 HEATING WITH 540nm GREEN LIGHT LASER	21
7	CHAPTER – 5 RESULT AND DISCUSSION	23
8	CHAPTER – 6 CONCLUSION	24
9	REFERENCES	25

LIST OF FIGURES

FIG NO	FIG NAME	PAGE NO
Fig:4.1	Au Nps at 488nm	20
Fig:4.2	Ag Nps at 488nm	20
Fig:4.3	Au Nps at 540nm	21
Fig:4.4	Ag Nps at 540nm	22

ABSTRACT

Comparative research on the heating of gold ultrafine particles and silver ultrafine particles was undertaken to determine an appropriate frequency and substance with greater photothermal effectiveness for hyperthermic use in cancer therapy. At 488nm and 540nm, gold nanoparticles are found to be greater photothermally efficient than silver nanoparticles. The 540nm laser burns gold nanoparticles greater than the 488nm laser. Silver nanoparticles, on the other hand, show a little lower temperature increase at 540nm than at 488nm. In the diametral surface range of 0-50nm, size-dependent impact research shows that the absorbance effectiveness of Single gold nanoparticulate with larger diameters is larger than those with lower diameters.

Keywords: Nanoparticles, Nanofluids, laser heating, Wavelength

CHAPTER – 1

INTRODUCTION

Considering the widespread use of nanoparticles in applications, the heating of gold nanoparticles and silver nanoparticles in liquid environments, where the nanoparticle temperature can rise substantially and subsequently be passed on to molecules in the vicinity, is of particular interest. Silver nanoparticles are extremely small silver particles. They range in size from ten to a hundred nanometres and differ from bulk silver in that they have diverse hues, such as yellow, rather than silver. Application of silver nanoparticulate (Ag NPs) are multifaceted because of their peculiar chemical and physical features, they are continuously employed in a wide range of fields including, healthcare, pharmaceutical, food supplies, industrial and consumer goods. Their unique feature includes high conductivity in the electrical field and in several other fields such as optical, magnetic recording thermal cancer treatment computer chips nanostructural growth and electrical.

A silver-water nanofluid is suggested, and the nanofluid is investigated to see how modifications in the flow of its volume and the concentration, ranging from 0 to 10 mg/L, impact the total heat transfer coefficient of a CR14-45 COMER plate heat exchanger (PHE) and the thermal properties of the nanofluid. The results show that nanofluid concentration and volume flow rate enhance the overall heat transfer coefficient of PHE

Metal nanoparticulate such as copper (Cu), carbon nanotubes (CNTs), silver (Ag), and gold (Au), are predominantly known nanoparticulate that are used to improve electrical conductivity and thermal conductivity. At the nanoscale scale NPS function as very efficient localised heat sources. This one-of-a-kind characteristic has a wide range of applications, including protein imaging, biomedicine, chemical catalysis and energy.

Nanofluid coolants may be used for a variety of mechanical and technological applications, including transformer cooling, automobile cooling, computer cooling, electronics cooling, and electronic device cooling, thanks to their superior thermophysical properties.

Due to their improved thermophysical characteristics, nanofluids have a wide range of uses in the engineering and healthcare fields. Industrial cooling, smart fluids, the nanofluid coolant used in automotive cooling, electronics cooling, and medicinal applications like magnetic drug targeting and nanocryosurgery are a few examples of heat transfer applications. Radiators might be smaller and placed better if nanofluids were used as heat exchangers.

Gold nanoparticles (Au NPs), often known as colloid gold or gold, are a suspension of sub-micrometre-sized particles (10nm or larger) in a fluid, often water. If the particle is smaller than 100nm in size, the suspension normally has a bright red hue, but if it is bigger, the suspension has a filthy yellowish tint. Gold nanoparticles are employed in resonance scattering dark-field microscopy to detect microbiological species and their metabolites to bio-imaging tumour cells to detect receptors on their surface and to research endocytosis. Many energy sources have been researched in the context of nanomaterial-mediated hyperthermia, including radio frequency (RF) waves, infrared (IR) lasers, and visible light lasers. Normally, the region of malignant tissue must be maintained above 42°C for a set amount of time to order to kill cancer cells. The wide penetration depth of RF wave heating is a plus. Sadly, the heating impact is minimal, and the heating process is still in the early stages. Despite its modest penetration depth, visible light laser heating has a significant heating impact because of the surface Plasmon resonance (SPR) effect. Laser light given through a directed optical fibre is one minimally invasive treatment for deep-seated tumours.

CHAPTER – 2

LITERATURE SURVEY

Adleman JR, Boyd DA, Goodwin DG, Psaltis D (2009) - Heterogenous catalysis mediated by plasmon heating. When a low-power laser is used to light nanoscale metal catalysts, the approach makes use of the plasmon resonance to generate the required heat of the reaction. By reforming a flowing, liquid combination of ethanol and water over gold nanoparticle catalysts in a microfluidic channel, we show the effectiveness of our method. The reaction's observed CO₂, CO, and H₂ by-products are in accord with the catalytic steam reforming of ethanol. The method, which we call plasmon-assisted catalysis, is all-encompassing and may be used for several endothermic catalytic processes involving nanoparticles.

Atwater HA, Polman A (2010) - plasmonics researchers are turning their attention to photovoltaics, where design approaches based on plasmonics can be used to improve absorption in photovoltaic devices, permitting a considerable reduction in the physical thickness of solar photovoltaic absorber layers, and yielding new options for solar-cell design. we survey recent advances at the intersection of plasmonics and photovoltaics and offer an outlook on the future of solar cells based on these principles.

Bickford L., Chang J., Fu K., Sun J., Hu Y., Gobin A., Yu T.K., Drezek R. Nanobiotechnology (2008) - This work provides an overview of the recent advances and current challenges facing the biomedical application of gold nanoparticles of various sizes, shapes, and structures. The review is focused on the application of gold nanoparticle conjugates in biomedical diagnostics and analytics, photothermal and photodynamic therapies, as a carrier for delivering target molecules, and on the immunological and toxicological properties.

Boyd DA, Greengard L, Brongersma L, El-Naggar MY, Goodwin DG (2006) - The technique demonstrated here refer to as plasmon-assisted CVD (PACVD), by patterning the spatial deposition of PbO and TiO₂ on glass substrates coated with a dispersion of 23 nm gold particles. The morphology of both oxide deposits is consistent with local laser-induced heating of the gold particles by more than 150 degrees C. We show that temperature changes of this magnitude are consistent with our analysis of the heat-loss mechanisms. The technique is general and can be used to spatially control the deposition of virtually any material for which a CVD process exists.

Cai W, White JS, Brongersma ML (2009) - Compact, high-speed and power-efficient electrooptic plasmonic modulators here it is investigated detailed design and optimization protocols for electrooptic plasmonic modulators that are suitable for free-space coupling and on-chip integration. The metallic structures in the proposed devices offer simultaneous electric and optical functions. The resonance-enhanced nonlinear interaction and submicrometer footprint of these devices meet the stringent requirements for future CMOS modulators, allowing for high-speed operation.

Cao L, Barsic DN, Guichard AR, Brongersma ML (2007) – In this paper, they have demonstrated a new versatile strategy to rapidly heat and cool subdiffraction-limited volumes of material with a focused light beam. The local temperature rise is obtained by exploiting the unique optical properties of metallic nanostructures that facilitate efficient light-to-heat conversion through the excitation of surface plasmons (collective electron oscillations). By locally heating nanoscale metallic catalysts, growth of semiconductor nanowires and carbon nanotubes can be initiated and controlled at arbitrarily prespecified locations and down to the single nanostructure level in a room-temperature chamber by this method inspires new pathways for manipulating a range of important thermally stimulated processes and the development of novel photothermal devices.

Challener WA, Peng C, Itagi AV, Karns D, Peng W, Peng Y, Yang XM, Zhu X, Gokemeijer NJ, Hsia Y-T, Ju G, Rottmayer RE, Seigler MA, Gage EC (2009) – In this paper, it has presented a multi-functional instrument for testing HAMR media, which integrates HAMR writing, reading, and a micro-magneto-optic Kerr effect (μ -MOKE) testing function. A potential application of the present instrument is to make temperature-dependent magnetic property measurements using a pump-probe configuration. In the measurement, the media is heated up by a heating (intense) beam while a testing (weak) beam is overlapped with the heating beam for MOKE measurement. By heating the media with different heating beam power, magnetic measurements by MOKE at different temperatures can be performed.

Chen, S., Pei, R., Zhao, T., and Dyer, D.J. (2002) - In this paper gold nanoparticles were constructed by exploiting the complexation interaction between divalent metal ions and pyridine moieties. The effect of the nature of the electrolyte ions was investigated in the context of their hydrophobicity and interaction with surface-bound particle molecules. It was found that the onset volumetric potential as well as the effective molecular capacitance of the nanoparticles were sensitive to the solution composition.

C.H. Li, G.P. Peterson (2007) - The steady-state method was used to evaluate the effective thermal conductivity of Al_2O_3 /distilled water nanofluids. Tests were conducted over a temperature range of 27–37 °C for volume fractions ranging from 0.5% to 6.0%. The most significant finding was the effect that variations in particle size had on the effective thermal conductivity of the Al_2O_3 /distilled water nanofluids. The largest enhancement difference observed occurred at a temperature of approximately 32 °C and at a volume fraction of between 2% and 4%. The experimental results exhibited a peak in the enhancement factor in this range of volume fractions for the temperature range evaluated, which implies that an optimal size exists for different nanoparticle and base fluid combinations.

Choudhuri B, Mondal A, Dhar JC, Singh NK, Goswami T, Chattopadhyay KK (2013) - They have examined the synthesis of indium (In) nanoparticle (NP) arrays on TiO₂ thin film (TF) using the glancing angle deposition technique. The deposited In NPs are of the order of 4–10 nm in size. Optical absorption measurements depict 2.5 times enhanced absorption for In-NPs/TiO₂-TF compared to TiO₂ TF. The device current increases from 1.6 to 6.5 mA/cm² (+5 V) with enhanced temperature for 1–30 min continuous light exposures. The plasmonic device shows eight-fold enlarged photoresponsivity (+2.3 V) compared to the TiO₂ TF-based device.

Christopher P, Xin HL, Linic S (2011) - They have shown that plasmonic nanostructures of silver can concurrently use low-intensity visible light (on the order of solar intensity) and thermal energy to drive catalytic oxidation reactions such as ethylene epoxidation, CO oxidation, and NH₃ oxidation--at lower temperatures than their conventional counterparts that use only thermal stimulus. Based on kinetic isotope experiments and density functional calculations, we postulate that excited plasmons on the silver surface act to populate O₂ antibonding orbitals and so form a transient negative-ion state, which thereby facilitates the rate-limiting O₂-dissociation reaction.

C.-Y. Wen, M. Tang, J. Hu, L.-L. Wu, D.-W. Pang, J.-B. Zeng, and X.-Y. Li, Anal (2016) - Using fluorescent nanospheres (FNs) as reporters, a quantitative lateral flow test with great sensitivity for protein biomarkers was developed. Since each fluorescent nanosphere (FN) includes 332 8 CdSe/ZnS quantum dots (QDs), the luminosity of each FN is 380 times stronger than that of a single QD. Then, using an immunofluorescent nanosphere (IFN)-based lateral flow test strip, a detection limit of 27.8 pM C-reaction protein (CRP) could be attained. The assay's sensitivity for detecting CRP was 257 times more than that of a typical Au-based lateral flow test strip. Additionally, after 6 months of storage, both the bioactivity of IFNs and the fluorescence intensity of FNs remained steady. With intra-assay variability of 5.3% and inter-assay variability of 6.6%, the test has high repeatability.

Eastman, J.A., Choi, S.U.S., Li, S., Yu, W., Thompson, L.J. (2001) - It is demonstrated that ethylene glycol with the same volume percent of scattered oxide nanoparticles has a substantially lower effective thermal conductivity than pure ethylene glycol and ethylene glycol that contains copper nanometer-sized particles dispersed in it. It has been demonstrated that adding about 0.3 vol% of Cu nanoparticles with a mean diameter of 10 nm to ethylene glycol may boost its effective thermal conductivity by up to 40%. Based on earlier theoretical predictions, which expected little influence of particle size or particle thermal conductivity but a large effect of particle shape on effective nanofluid thermal conductivity, the results are abnormal.

Erickson D, Sinton D, Psaltis D (2011) - In this paper, the authors describe the possibilities for applying these same capabilities to the field of energy. We focus on optofluidic opportunities in sunlight-based fuel production in photobioreactors and photocatalytic systems, as well as up to fluidically enabled solar energy collection and control. We then provide a series of physical and scaling arguments that demonstrate the potential benefits of incorporating optofluidic elements into energy systems.

Falcaro, P., Ricco, R., Yazdi, A., Imaz, I., Furukawa, S., Maspoche, D., Ameloot, R., Evans, J.D., and Doonan, C.J.(2015) - This review summarizes the developed strategies for the fabrication of nanoparticle/MOF composites for catalyst use, including the strategy using MOFs as host materials to hold and stabilize the guest nanoparticles, the strategy with subsequent MOF growth/assembly around pre-synthesized nanoparticles and the strategy mixing the precursors of NPs and MOFs together, followed by self-assembly process or post-treatment or post-modification. The applications of nanoparticle/MOF composites for CO oxidation, CO₂ conversion, hydrogen production, organic transformations, and degradation of pollutants have been discussed.

Fedele, L., Colla, L., & Bobbo, S. (2012) - Titanium oxide (TiO₂) at concentrations ranging from 1 to 35% in mass is found in water-based nanofluids, and their characterisation is described. First, the mean nanoparticle sizes are investigated using the dynamic light scattering (DLS) method, and the stability of the nanofluid is examined using measurements of the zeta potential. Then, using a rheometer in the temperature range of 283 K to 343 K, the behaviour of viscosity as a function of composition and temperature is assessed. Additionally, the thermal conductivity of these nanofluids is examined in order to comprehend how temperature and nanoparticle concentration may affect its potential improvement.

H.-J. Chen and D. Wen, (2011) - The possibility of creating aqueous, spherical gold nanoparticles (GNPs) under air conditions were investigated using a standard ultrasonic bath. Investigations were also done on how ultrasonic energy affected the size and shape of GNPs. UV-visible spectra and transmission electron microscopy show that sodium citrate reduction in a typical ultrasonic bath, without the use of an extra heater or magnetic stirrer, effectively produced highly monodispersed spherical GNPs. It has been demonstrated that ultrasonic energy is a crucial factor in the production of spherical GNPs with adjustable diameters (20 to 50 nm). The role of ultrasonic energy in the development and growth of GNPs was examined using a suggested strategy.

Hu R., Yong K.T., Roy I., Ding H., He S., Prasad P.N.J. P (2009) - A green synthetic approach using olive leaf extract was optimized for preparing silver nanoparticles (AgNPs). Parameters affecting the formation of nanoparticles such as temperature, exposure time to extract, pH, the concentration of silver nitrate, and extract (ratio of plant sample to extraction solvent) were investigated and optimized. Optimum conditions for the synthesis of silver nanoparticles are Ag concentration 1 mM, extract concentration, 8 % w/v; pH = 7, time, 4 h and temperature, 45°C. Synthesized silver nanoparticles were characterized using UV-Visible absorption spectroscopy, X-ray diffraction, DLS, and SEM. SEM and DLS analysis showed that the synthesized AgNPs were predominantly spherical in shape with an average size of 90 nm.

Ibrahimkuty S, Kim J, Cammarata M, Ewald F, Choi J, Ihee H, Plech A (2011) - Protein-coated gold nanoparticles in suspension are excited by intense laser pulses to mimic the light-induced effect on biomolecules that occur in photothermal laser therapy with nanoparticles as photosensitizer. Ultrafast X-ray scattering employed to access the nanoscale structural modifications of the protein—nanoparticle hybrid reveals that the protein shell is expelled without denaturation at a laser fluence that coincides with the bubble formation threshold. Consequently, the laser pulse length has a strong influence on whether the result is the ligand detachment (for example drug delivery) or biomaterial degradation.

Kaufui VW, Omar DL (2010) - This paper focuses on presenting the broad range of current and future applications that involve nanofluids, emphasizing their improved heat transfer properties that are controllable and the specific characteristics that these nanofluids possess that make them suitable for such applications. Nanofluids are suspensions of nanoparticles in fluids that show significant enhancement of their properties at modest nanoparticle concentrations. Nanofluid as a smart fluid, where heat transfer can be reduced or enhanced at will, has also been reported.

Lee J, Govorov AO, Kotov NA (2005) - A temperature-dependent emission is observed for CdTe nanoparticles connected to Au nanoparticles by a flexible poly(ethyleneglycol) (PEG) link acting as a molecular spring. The extension of the PEG springs varies depending on the temperature, which causes variations in CdTe emission caused by plasmon—exciton interactions. A theoretical model of plasmon—exciton coupling explains the optical and thermal effects.

Li W.R., Xie X.B., Shi Q.S., Zeng H.Y., Ou-Yang Y.S., Chen Y.B. (2010) - The antibacterial activity and acting mechanism of silver nanoparticles (SNPs) on *Escherichia coli* ATCC 8739 were investigated in this study by analyzing the growth, permeability, and morphology of the bacterial cells following treatment with SNPs. After being exposed to 10 micron/ml SNPs, the membrane vesicles were dissolved and dispersed, and their membrane components became disorganized and scattered from their original ordered and close arrangement based on TEM observation. In conclusion, the combined results suggested that SNPs may damage the structure of bacterial cell membranes and depress the activity of some membranous enzymes, which cause *E. coli* bacteria to die eventually.

Lowery A, Gobin A, Day E, Halas N, West J (2006) - In vitro studies have confirmed the ability to selectively induce cell death with the photothermal interaction of immunonanoshells and NIR light. Prior to incubation with anti-human epidermal growth factor receptor (HER2) immunonanoshells, HER2-expressing SK-BR-3 breast carcinoma cells were seeded alone or adjacent to human dermal fibroblasts (HDFs). Anti-HER2 immunonanoshells bound to HER2-expressing cells resulted in the death of SK-BR-3 cells after NIR exposure only within the irradiated area, while HDFs remained viable after similar treatment since the immunonanoshells did not bind to these cells at high levels.

L.S. Sundar, M.K. Singh, A.C.M. Sousa (2013) - Authors have created the nanoparticles using an in-situ method that involved dispersing caboxylated nanodiamond (c-ND) nanoparticles in ethylene glycol (EG), mixing nickel chloride, and using sodium borohydrate as the reducing agent at a reaction temperature of 140°C to create ND-Ni nanoparticles. These nanoparticles were then thoroughly characterised for their surface and magnetic properties using X-ray, micro-Raman, high By dispersing ND-Ni nanoparticles in a solution of water and EG, they created stable magnetic nanofluids. We carried out tests to quantify the thermal conductivity and viscosity of the nanofluid at various nanoparticle loadings. The greatest thermal conductivity boost of the nanofluid for a 3.03% weight of ND-Ni nanoparticles

distributed in water and EG is 21%, while the maximum thermal conductivity augmentation is 13%.

M. Chandrasekar, S. Suresh, A. Chandra Bose (2010) - This research examines the thermal conductivity and viscosity of an $\text{Al}_2\text{O}_3/\text{H}_2\text{O}$ nanofluid. The Al_2O_3 nanoparticles were created using the microwave-aided chemical precipitation process, and the nanofluid was created by dispersing them in distilled water using a sonicator. For the research, several volume concentrations of Al_2O_3 /water nanofluid (0.33-5%) with a nominal diameter of 43 nm were utilised. When the viscosity and thermal conductivity of nanofluids is tested, it is discovered that the viscosity increase is significantly more than the thermal conductivity rise. With increasing nanoparticle volume concentration, nanofluids become more viscous and thermally conductive.

Mukherjee P., Ahmad A., Mandal D., Senapati S., Sainkar S.R., Khan M.I., Renu P., Ajaykumar P.V., Alam M., Kumar R.,(2001) - Exposure of the fungal biomass to aqueous Ag^+ ions resulted in the intracellular reduction of the metal ions and formation of silver nanoparticles of dimensions 25 ± 12 nm. Electron microscopy analysis of thin sections of the fungal cells indicated that the silver particles were formed below the cell wall surface, possibly due to reduction of the metal ions by enzymes present in the cell wall membrane. The metal ions were not toxic to the fungal cells and the cells continued to multiply after biosynthesis of the silver nanoparticles.

Mutuku, W.N. (2016) - In this paper, the cooling capabilities of an ethylene glycol (EG)-based nanofluid containing three different types of nanoparticles: copper oxide (CuO), aluminium oxide (Al_2O_3), and titanium dioxide (TiO_2) are investigated. Nanofluids have enhanced thermophysical properties, hence they can be used in a plethora mechanical and engineering applications such as nanofluid coolant: electronics cooling, vehicle cooling, transformer cooling, computers cooling and electronic devices cooling. A parametric study of the entire flow regime is carried out to illustrate the effects of the pertinent parameters on the velocity, temperature, skin friction coefficient and the local Nusselt number.

Mutuku WN, Makinde OD (2014) - The magnetohydrodynamics (MHD) boundary layer flow of nanofluids past a permeable moving flat plate with convective heating at the plate surface has been studied. The model equations are obtained and solved numerically by applying shooting iteration technique together with the fourth order Runge-Kutta-Fehlberg integration scheme. The influence of pertinent parameters on velocity, temperature, skin friction and Nusselt number are investigated. The obtained results are presented graphically and the physical aspects of the problem discussed quantitatively.

O'Neal D, Hirsch L, Halas N, Payne J, West J (2004) - The following study examines the feasibility of nanoshell-assisted photo-thermal therapy (NAPT). This technique takes advantage of the strong near infrared (NIR) absorption of nanoshells, a new class of gold nanoparticles with tunable optical absorptivities that can undergo passive extravasation from the abnormal tumor vasculature due to their nanoscale size. Control animals and additional sham-treatment animals (laser treatment without nanoshell injection) were euthanized when tumors grew to a predetermined size, which occurred 6-19 days post-treatment. This simple, non-invasive procedure shows great promise as a technique for selective photo-thermal tumor ablation.

Pourhoseini, S. H., Naghizadeh, N., & Hoseinzadeh, H (2018) - This paper indicate that both nanofluid concentration and volume flow rate enhance the overall heat transfer coefficient of PHE. As the concentration of silver nanoparticles in water increases, thermal conductivity initially rises to a maximum at a concentration of about 2.5 mg/L. The thermal conductivity of silver-water nanofluid in such a state is 36.6% greater than that of pure water. However, due to aggregation phenomenon and smaller area-to-volume fraction (A/V) at high concentrations, the effective thermal conductivity decreases.

Pourfarhang, S, Zeinali Heris, S, Shokrgozar, M, Kahani, M., " (2015) - We investigated the role of nanofluid in a special car radiator and the effect of its different volume concentrations on pressure drop and friction factor of fluid flow. A mixture of 60/40 ratio of ethylene glycol (EG) and distilled water was used as the host fluid and CuO nanoparticles were dispersed well to make stable nanofluids. The influence of nanofluid concentrations on pressure drop was evaluated in the radiator at three different inlet fluid temperatures (35, 44, 54 °C). The results demonstrated that the presence of nanoparticles caused an increase in nanofluid pressure drop, which was intensified by increasing nanoparticle concentration as well as decreasing temperature of inlet fluid.

Schuller JA, Taubner T, Brongersma ML (2009) Optical antennas are a critical component in nanophotonics research and have been used to enhance nonlinear and Raman cross-sections and to make nanoscale optical probes. In these applications the antenna must operate at frequencies given by existing light emitters. Using thermal excitation of optical antennas, we bypass this limitation and realize emitters at infrared frequencies where sources are less readily available. Combined with advancing progress in antenna design, these results could lead to optical antenna emitters operating throughout the infrared frequency range.

S.K. Das, N. Putra, P. Thiesen, W. Roetzel S.K. Das, N. Putra, P. Thiesen, W. Roetzel (2003) - As a new level in heat transfer operations, nanofluids are ordinary heat transfer fluids with suspended extremely tiny particles of nanometer size. Recent studies have shown that nanofluids can improve heat transmission, which is important for modern technologies. In the current inquiry, thermal conductivity for nanofluids with water as the base fluid and Al₂O₃ or CuO particles as the suspension material is investigated in depth. Thermal diffusivity is measured using a temperature oscillation approach, and thermal conductivity is derived from it. The findings show that enhancing properties grow with temperature, which makes nanofluids much more appealing for high energy density applications than previously reported normal room temperature data.

S.U.S. Choi (1995) - They suggest that by suspending metallic nanoparticles in traditional heat transfer fluids, a whole new class of heat transfer fluids may be created. The resultant nanofluids hold the most potential for improving heat transmission since they are predicted to have high thermal conductivities when compared to those of the heat transfer fluids already in use. The findings of a theoretical investigation into the thermal conductivity of copper nanophase materials in nanofluids are presented, along with an estimation of the fluids' potential advantages. It is demonstrated that one of these advantages will be a significant decrease in the amount of power needed to pump heat exchangers.

Timofeeva, E.V., Yu, W., France, D.M., Singh, D., Routbort, J.L. (2011) - It is explained how the viscosity, thermal conductivity, and cooling efficiency of nanofluids are affected at the nanoscale. Because of the extraordinarily high surface-to-volume ratio in nanofluids, a nanoparticle suspension is thought of as a three-phase system consisting of the solid phase (nanoparticles), the liquid phase (fluid medium), and the interfacial phase. A thorough analysis of numerous parameters in the multivariable nanofluid systems was produced because of using the systems engineering method to nanofluid design. Engineering nanofluids with the appropriate set of attributes is made possible by the relative significance of nanofluid parameters for heat transfer examined in this article.

Villarrubia JS, Vladár AE, Ming B, Kline RJ, Sunday DF, Chawla JS, (2015) - The width and shape of 10nm to 12 nm wide lithographically patterned SiO₂ lines were measured in the scanning electron microscope by fitting the measured intensity vs position to a physics-based model in which the lines' widths and shapes are parameters. These pose a challenge: the narrowness because electrons landing near one edge may scatter out of the other, so that the intensity profile at each edge becomes width-dependent, and the asymmetry because the shape requires more parameters to describe and measure. Modeling was performed by which produces a predicted yield vs position for a given sample shape and composition.

Von Maltzahn G, Park J-H, Lin KY, Singh N, Schwöppe C, Mesters R, Berdel WE, Ruoslahti E, Sailor MJ, Bhatia SN (2011) - Nanomedicines have enormous potential to improve the precision of cancer therapy, yet our ability to efficiently home these materials to regions of disease in vivo remains very limited. These systems are composed of 'signalling' modules (nanoparticles or engineered proteins) that target tumours and then locally activate the coagulation cascade to broadcast tumour location to clot-targeted 'receiving' nanoparticles in circulation that carry a diagnostic or therapeutic cargo, thereby amplifying their delivery. We show that communicating nanoparticle systems can be composed of multiple types of signalling and receiving modules, can transmit information through multiple molecular pathways in coagulation, can operate autonomously and can target over 40 times higher doses of chemotherapeutics to tumours than non-communicating controls.

Wang S.-H., Lee C.-W., Chiou A., Wei P.K.J. (2010) - It is critical to comprehend the endocytosis of gold nanoparticles (AuNPs) for applications in medication administration and photodynamic treatment. Fluorescent microscopy is typically used to study endocytosis in live cells. Photobleaching affects the fluorescent labelling. Additionally, it is difficult to estimate the cellular uptake quantitatively. In this study, the size-dependent endocytosis of AuNPs was examined utilising unlabeled plasmonic scattering pictures.

York J., Spetzler D., Hornung T., Ishmukhametov R., Martin J., Frasch W.D. J. Bioenerg.(2007) - Using gold nanorods linked to the γ -subunit, the quantity of E. coli F1-ATPase molecules that rotated was measured. Based on time-dependent variations of the red and green light scattered from the nanorods when examined via a polarising filter, individual F1 molecules were shown to be revolving. In the absence of nucleotides, GTP, and ATP, an average of 50, 25, and 4% of F1 molecules were found to spin, respectively. As much as 65% of molecules were found to spin in certain assays when GTP was present. These findings suggest that gold nanorod rotational measurements can provide details about the F1-ATPase mechanism that are reflective of the traits of the enzyme population.

Zhu, D., Li, X., Wang, N., Wang, X., Gao, J., Li, H., 2009 In this study, Al₂O₃–H₂O nanofluids were synthesized, and their dispersion behaviours and thermal conductivity in water were investigated under different pH values and different (SDBS) concentrations. The zeta potential and particle size of the particles were measured and the (DLVO) theory was used to calculate attractive and repulsive potentials. The thermal conductivity was measured by a hot disk thermal constants analyser. The results showed that the stability and thermal conductivity enhancements of Al₂O₃–H₂O nanofluids are highly dependent on pH values and different SDBS dispersant concentrations of nano-suspensions. The Al₂O₃–H₂O nanofluids with an ounce of Al₂O₃ have noticeably higher thermal conductivity than the base fluid without nanoparticles, for Al₂O₃ nanoparticles at a weight fraction of (0.15wt%), thermal conductivity was enhanced by up to 10.1

CHAPTER – 3

AIM AND SCOPE

3.1 AIM

The aim of the present investigation is to study the properties and behaviour of the nanofluids in this we can able to investigate their thermal properties, density, and viscosity these investigations can be used in the field of science. The nanofluids are prepared with different nanoparticles and mixtures of base fluids along with surfactant to form stable nanofluids these fluids can be tested and used for cooling applications.

3.2 EXISTING RESEARCH

Much research is experimentally done with various base fluids such as ethylene glycol, EG and water, water with various nanoparticles such as gold, silver, titanium oxides, copper oxides, MWCNT, CNT and magnesium oxides with various volume fractions. Still, much research is undergone with nanofluids for thermal conductivity to find a better nanofluid coolant with higher thermal conductivity

3.3 SCOPE

Future applications for this research include the use of nanofluid coolants in heat-exchangers, generators, electronics, vehicle cooling, computer cooling, and cooling in the chip manufacturing industry. A recent study shows that MWCNT exhibits higher thermal conductivity, and by combining a variety of base fluids, surfactants, nanoparticles, and mixtures, we can create a better coolant for a variety of industries.

CHAPTER – 4

MATERIAL AND METHODOLOGY

4.1 FORMATION OF NANOPARTICLE

With the use of ultra-sonification, the citrate reduction technique was employed to produce gold nanoparticles. In summary, 5.0×10^{-5} mole of Chloroauric acid was warmed in 190gm of Deionised water until it gets to a boil. Whereas the possible solution is to boil and stirred with a magnetic stirrer, sodium citrate 10gm of 0.5% was supplied. The mixture was continuously mixed over the subsequent 1800 seconds until the process was complete. The sodium citrate to the chloroauric acid ratio used in manufacture may be changed to affect the size of GNP. The original mixture was dissolved into four unique concentrations: 8.77, 5.84, 4.38, 2.92, and 1.46 mg/dL, followed by 180 seconds of ultra-sonification. The shape and size of gold nanoparticles are examined using an Energy Dispersive X-ray spectroscope (EDX). and a Transmission electron microscope (TEM)

A polyol technique was used to create the silver nanoparticles. 15gm of unadulterated EG (Ethylene glycol) was warmed at 153°C for an hour for a typical synthesis. For 900 seconds, 240gm of FeCl_3 EG solution (4mM) was introduced dropwise into the hot flask. Then 2.25gm of a 0.17M (polyvinylpyrrolidone) solution was added to EG. The flask was then filled with 4.5gm of 0.094M silver nitrate solution in EG. The combined solution was allowed to react for two hours before being cooled to room temperature. The product was rinsed with acetone at least three times and ethanol twice. For the following experiment, purified silver nanoparticles were distributed in ethanol. Transmission electron microscopy (TEM) and scanning electronic microscopy (SEM) was used to examine the genetics of nanomaterials.

4.2 STUDY OF LASER HEATING EXPERIMENT

4.2.1 *Setup for the Experiment and Heating Method*

In a radiation shielding room, a supernatant was put on a substrate for thermal insulation. The solid-state lasers 540nm green light and 488nm purple light, were focused on each set of samples through a hole in the chamber's roof. The thermal imaging camera was positioned outside the chamber, sensing an IR signal from the heated sample to observe and study the temperature gradient inside the sample. Meanwhile, a four-channel fibre optical temperature sensor was used to monitor precise temperatures. The thermal imager (CEM DT-980) was only used to continuously monitor the temperature profile of the heated sample because it has a temperature accuracy of $\pm 2^{\circ}\text{C}$. The fiber optic temperature sensor (OMEGA FOB-100 series) has a measurement precision of $\pm 0.1^{\circ}\text{C}$ and can monitor temperature from several points. The heating of nanofluids was accomplished in a series of phases. The samples were prepared to a concentration of 0, 1.46, 2.92, 4.38, 5.84, and 8.77 mg/dL. The lasers were put on at full power (500mW for 540nm, 300mW for 488nm) and lit each sample for 600 seconds. The temperature was measured using automated data gathering software. After 600 seconds, the thermal imager captured IR thermal imaging of the sample.

4.2.2 *Heating with 488nm Purple Light Laser*

A dotted rectangle marks the region of the cuvette filled with samples. It is observed that when the concentration of gold nanoparticles and silver nanoparticles dispersions rises, so does the brightness of the sample region. The temperature increase for Deionised water is 1.45°C after 600 seconds of purple light exposure in fig:4.1 and fig:4.2.

As the concentration of silver nanoparticle samples rose, so did the temperature. When the concentration is less than 4.38mg/dL, the temperature increases for the three layers are nearly identical. For higher concentrations, the top layer showed a greater temperature rise than the middle and bottom layers. It has also been discovered that the intermediate layer is hotter than the bottom layer.

The temperature rise of gold nanoparticle samples is greater than for silver nanoparticle samples. For example, when the concentration is 8.77mg/dL, the temperature rise is 11.4°C, which is 4.3°C greater than that of the silver nanoparticles sample. Furthermore, the temperature rise in the top layer grows monotonically with increasing concentration. However, there is a concentration tipping point in the bottom layer at roughly 3.50mg/dL.

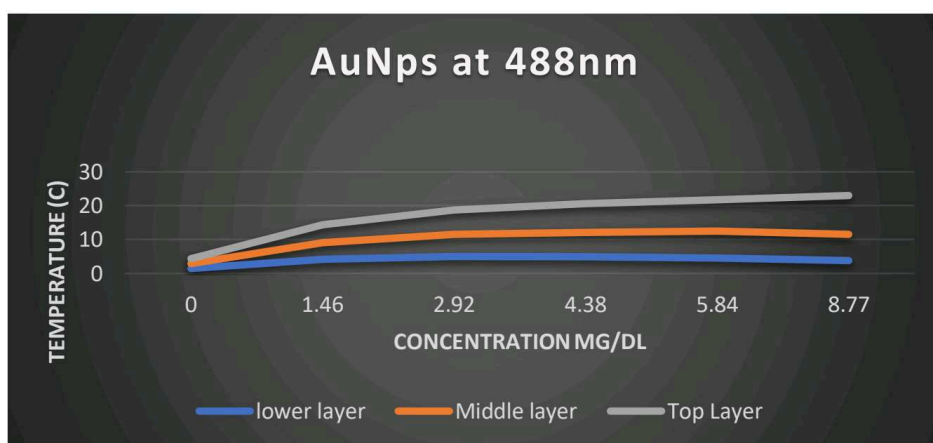


Fig:4.1: The graph explains the rise in temperature of AuNps at 488nm after heating with a laser for certain period

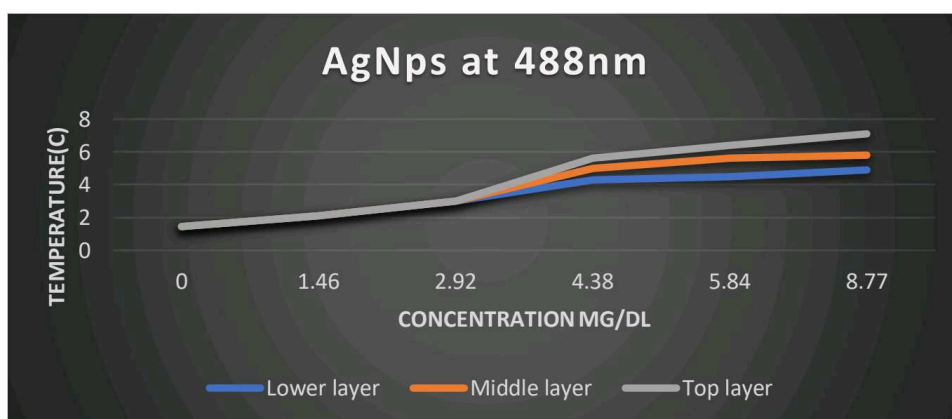


Fig:4.2: The graphical representation shows temperature rise in a certain interval of time in AgNps at 488nm after heating with a laser

4.2.3 Heating with 540nm Green Light Laser

After 600 seconds of 540nm laser heating, the temperature profiles of gold nanoparticles and silver nanoparticles are shown. Observations are like those observed with 488nm laser heating. Temperature measurement accuracy is demonstrated in fig:4.3 and fig:4.4.

The heating effect of the gold nanoparticle samples is quite comparable to that of purple light heating. However, the temperature rise for the top layer of the sample of 8.77mg/dL is 28.6°C, equal to 17.2°C when the green light is 300mW. As a result, the temperature rise is substantially greater than with purple light heating (11.4°C@300mW). Furthermore, the bottom layer's turning point has been changed to 2.33mg/dL.

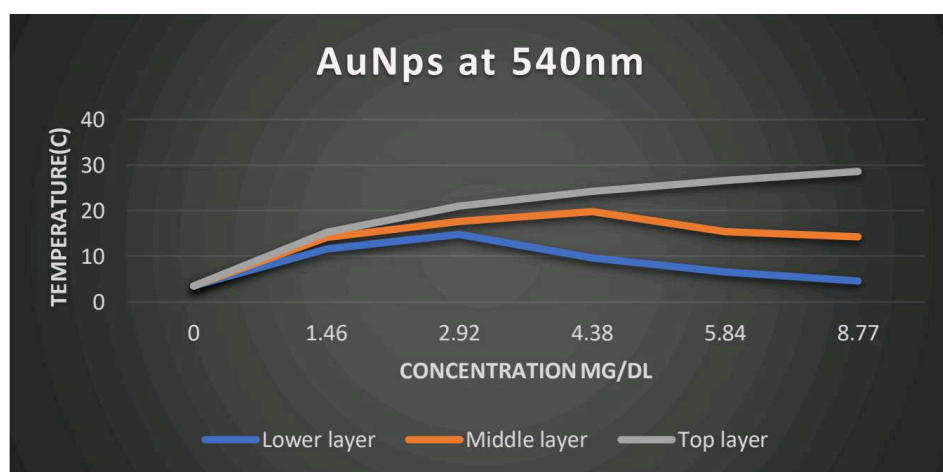


Fig:4.3: The data here explains the rise in temperature of AuNps at 540nm after heating it with a laser for a particular interval of time

The heating effect of the gold nanoparticle samples is quite comparable to that of purple light heating. However, the temperature rise for the top layer of the sample of 8.77mg/dL is 28.6°C, equal to 17.2°C when the green light is 300mW. As a result, the temperature rise is substantially greater than with purple light heating (11.4°C@300mW). Furthermore, the bottom layer's turning point has been changed to 2.33mg/dL.

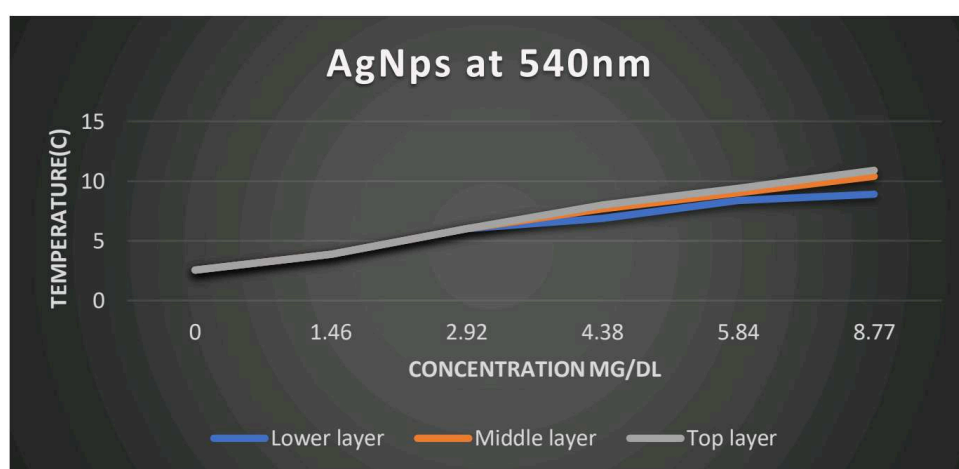


Fig:4.4: The data explains the behaviour of AgNps when heated for a certain period at 540nm with a laser

CHAPTER - 5

RESULTS AND DISCUSSION

5.1 RESULT AND DISCUSSION

At 540nm, gold nanoparticles absorb more efficiently than at 488nm. This describes why the 540nm laser produces more heat than the 488nm laser. In contrast, the absorbing effectiveness of silver nanoparticles at 488nm is larger than that at 540nm, which is like the fact that silver nanoparticles have a higher heating influence at 488nm. Therefore, the rate of absorption of the gold nanoparticulate is always larger than that of silver nanoparticles, which is in line with the scientific evidence. The result demonstrates that the Lower layer is always lower heated than the top layer owing to intensity reduction. As a result, there is a watershed moment over which the greater the absorbance factor, the less warm the lower layer. Experiment evidence supports this viewpoint. These phenomena can also be characterized by the fact that a decrease in intensity balances for an increase in absorption.

The lasers and the wavelength of the substance, following theoretical and empirical studies, are both crucial to photo-thermal ablation. The absorbance performance of a laser of a specified frequency varies with the substance. This does not necessarily indicate that the greater a nanomaterial's attenuation, the better. Tumors are not evenly warmed when high attenuation substances can be used because a greater absorption factor results in less heating activity in the bottom layer. As an outcome, high absorbance material is suitable for the therapy of surface tumors. For a considerably deeper hypodermic, specific identification of nanomaterial is required. Tissues exhibit varied attenuation to different laser wavelengths, which must be considered in determining a suitable laser.

CHAPTER – 6

CONCLUSION

6.1 CONCLUSION

Comparison research was carried out employing suspensions of gold nanoparticles and silver nanoparticles. In comparison to silver nanoparticle suspensions, gold nanoparticle suspensions are heated more by 488nm and 540nm lasers. Moreover, the samples are not heated evenly, resulting in a layered heating phenomenon. According to the theoretical model, there is an optimal attenuation coefficient for a certain depth, where the heating rate peaks. The optimal attenuation coefficient thus determines the ideal tumour size that may be treated. In this regard, a meticulous certain assessment will be conducted to test the dampening to make an appropriate assessment and consider the qualities of tissues and nanoparticles.

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