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# Synthesis of Nanoparticles Used For Solar Heating Purpose by Applying On Window

Nitish Pratap Singh Sengar[1], S.Kumar[2], Piyush Jha[3]
[1](Research Scholar, M.Tech. Thermal Engineering, Mechanical Engineering Department, Raipur Institute of Technology, Raipur, India)
[2](Professor, Mechanical Engineering Department, Raipur Institute of Technology, Raipur, India)
[3](Professor, Chemistry Department, Raipur Institute of Technology, Raipur, India)

***Abstract: The applications of passive heating techniques are increasing now these days. Further, the application of glass based windows and walls in the multistory buildings and complexes are also a new trend adopted by the building planners. For increasing the heat gain through glass windows/roofs different coatings have been analyzed in the present work. These coatings have been prepared by using different nanoparticles viz. magnesium oxide nanoparticle, copper oxide nanoparticle and aluminium oxide nanoparticle. It has been found that copper oxide based coating is best for increasing the heat gain.***
***Keyword: Passive cooling technique, Magnesium oxide nanoparticle, Copper oxide nanoparticle, Aluminium oxide nanoparticle, Glass and Thermocol.***

## I. INTRODUCTION

### *A. Glass*

Glass is a non-crystalline amorphous solid that is frequently transparent and has extensive practical and technological usage. The most well know and oldest types of glass are "silicate glasses" based on the chemical compound silica. Glass can transmit reflect and refract light, this type of properties of glass can be increase by cutting and polishing of glass. Engineering Properties of Glass are transparency, strength, workability, transmittance, U value and recycle property[1].

### *B. Solar radiation*

Solar radiation is also known as short-wave radiation. Solar radiation comes in various forms such as visible light, radio waves, heat (infrared), x-rays and ultraviolet rays.

Availability of solar radiation on earth surface is higher on sunny day and usually low on cloudy days. The sun is a source of heat radiations and it emits radiations in all the directions. The atmosphere absorbs heat radiations and air, clouds, dust particles etc. present in the atmosphere spread out the heat and light radiations. Obviously, the earth receives only a small part of the energy emitted by the sun.

Much of the solar radiation is transmitted through the glass covering and absorbed by the objects within the enclosure. Most of the thermal radiation emitted at low temperature is reflected back and remains inside. Because of this one way action of heat exchange of the glass the temperature within the enclosure becomes considerably higher than the ambient temperature outside. The phenomenon is commonly referred to as the greenhouse effect. The sky creates a partial greenhouse effect if it is heavily loaded with $CO_2$, $H_2O$ and to a lesser extent ozone[2].

### *C. Nanoparticles*

Nanoparticles are particles of size between 1 and 100 nanometers. In nanotechnology, a particle is defined as a small object that conducts as a whole unit with respect to its transport and properties. Scientific research on nanoparticles is acute as they have many potential applications in medicine, physics, optics, and electronics. The term "nanoparticle" is not usually applied to individual molecules; it usually refers to inorganic materials. Nanoparticles can demonstrate size-related properties importantly different from those of fine particles. There are several synthesis methods for creating nanoparticles like physical vapor deposition, chemical vapor deposition, sol-gel method, RF plasma method, pulsed laser method, thermolysis and combustion method. Combustion synthesis is an effective ecofriendly and low-cost method for preparation of nanoparticles[3][4][5].

## II. EXPERIMENTAL SET UP AND METHODOLOGY

### A. *Preparation of nanoparticles*

There are various methods available for synthesis of nanoparticles such as physical vapor deposition (PVD), chemical vapor deposition (CVD), sol-gel method, RF plasma method**,** pulsed laser method, thermolysis and combustion method. In the present work nanoparticles are synthesis by using combustion method. The combustion method is an easier method to make oxides of any element by using its nitrate. Equipments used for this process are muffle furnace, mortar and pestle, nitrates (copper nitrate, aluminium nitrate and magnesium nitrate), urea, crucible, pyrometer and weigh machine.

Table 1 Properties of chemical which used

| Property | Magnesium nitrate | Aluminium nitrate | Copper nitrate | Urea |
|---|---|---|---|---|
| Formula | $Mg(NO_3)_2$ | $Al(NO_3)_3$ | $Cu(NO_3)_2$ | $CH_4N_2O$ |
| Molar mass | 148.3 g/mol | 212.996g/mol | 187.56 g/mol | 60.06g/mol |
| Melting point | $89^0C$ | $72.8^0C$ | $114.5^0C$ | $133^0C$ |
| Density | $2.3g/cm^3$ | $1.72g/cm^3$ | $3.05g/cm^3$ | $1.32g/cm^3$ |

For the synthesis of nanoparticles by using combustion method initially the ratio between nitrates and urea has been calculated subsequently urea and nitrate are mixed in mortar to form a gel. The process of crushing and mixing of urea and nitrates took 5 to 6 minutes to form gel like solution. About 3 to 4 ml of distilled water is also added into the mixture of urea and nitrate during the formation of gel. The process of mixing results an exothermic reaction and small amount of heat is liberated when urea is added within it. After formation of gel like solution it has been placed into crucible and then crucible is placed into muffle furnace where temperature has been maintained around $550^0C$.


Figure 1 Muffle furnace at $550^0C$

Hot fumes with reddish flame come out of cup for 10-12 seconds and then the gel is converted into the oxides. With the help of tongue cup is taken out form the furnace and keep for 20 to 30 minute to cool.

### B. *Testing zone*

The testing setup consists of ten cubical shape structure made up of glass and polystyrene (Thermocol). Equipments used for this process are glass, polystyrene (thermocol), thermocouple, water bowl, adhesive (gum), Nanoparticles (magnesium oxide, aluminium oxide and copper oxide) and weigh machine.

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Figure 2 Experimental Setup

In the above figure glasses are coated with the mixture/paste of copper oxide nanoparticle and adhesive

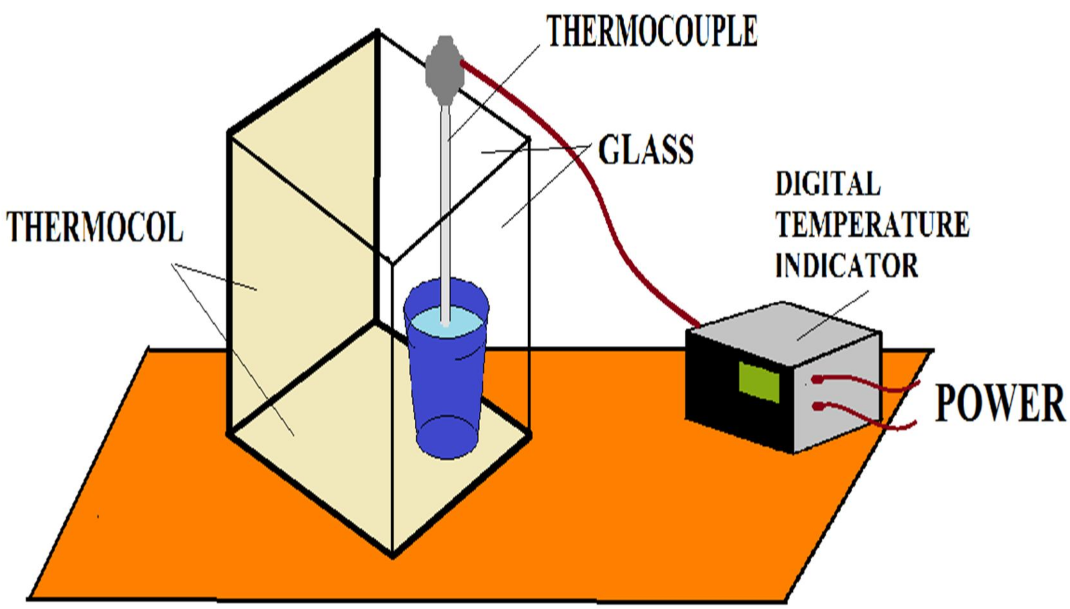


Figure 3 Schematic diagram

Ten different cubical structures of size 0.2×0.2×0.2 $m^3$ have been made for performing the experiments. These cubes are having four faces of glass and other two faces are of polystyrene (thermocol). All the cubical structures are made in similar manner as described above. Three cubical structures are coated with aluminium oxide nanoparticles using 5gm, 10gm and 15gm with the help of adhesive on the glass faces. Three cubical structures are coated with copper oxide nanoparticles using 5gm, 10gm and 15gm with the help of adhesive on the glass faces. Three cubical structures are coated with magnesium oxide nanoparticles using 5gm, 10gm and 15gm with the help of adhesive on the glass faces and one cubical structure is coated with only adhesive i.e. without nanoparticles on the glass faces. A bowl of water is kept inside the cubical structure setup and thermocouple is place to measure temperature of water. All the setup is kept in sunlight for 5-6 hrs.

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## III. RESULTS AND DISCUSSIONS

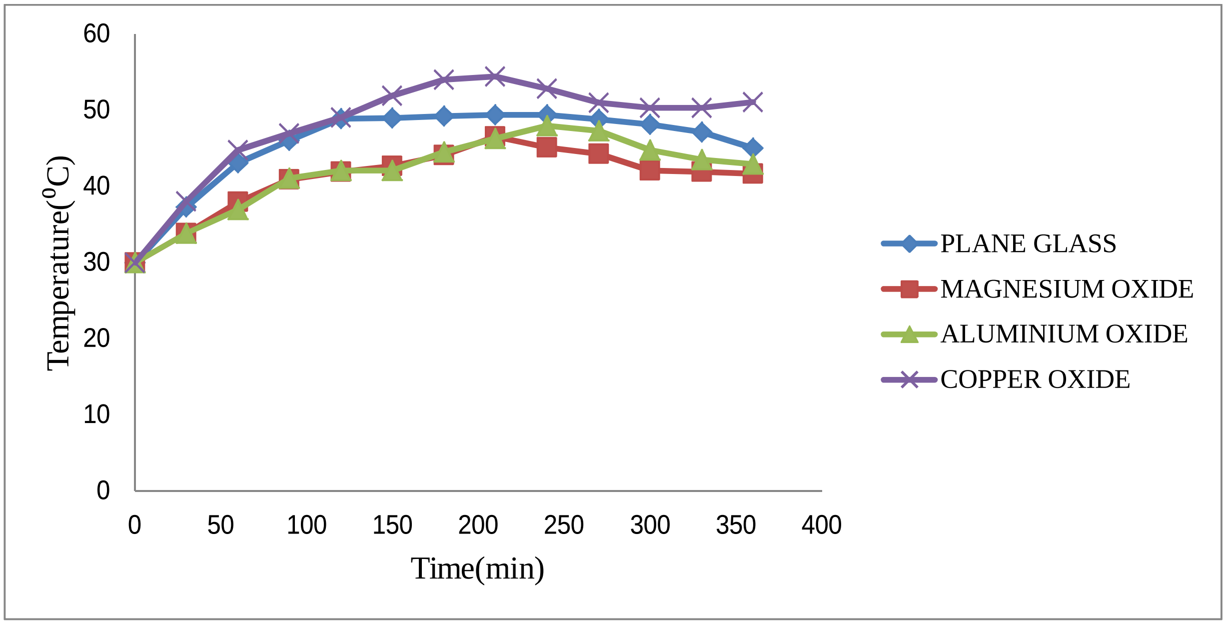


Figure 4 Comparison between time and temperature for 5gm nanoparticles

In the present work different types of nanoparticles have been prepared and applied over the test zone. The comparisons of solar heat gain in different conditions have been studied.

When 5gm nanoparticles are mixed with adhesive and coated on the glass faces-

a) Plane glass: Maximum temperature: 49.4$^0$C and minimum temperature: 30$^0$C.

b) Magnesium oxide nanoparticle: Maximum temperature: 46.5$^0$C and minimum temperature: 30$^0$C.

c) Aluminium oxide nanoparticle: Maximum temperature: 48$^0$C and minimum temperature: 30$^0$C.

d) Copper oxide nanoparticle: Maximum temperature: 54.4$^0$C and minimum temperature: 30$^0$C.

From the analysis of figure 4 it is clear that the solar heat gain in copper oxide is better than the other nanoparticles which have been used in the present work.

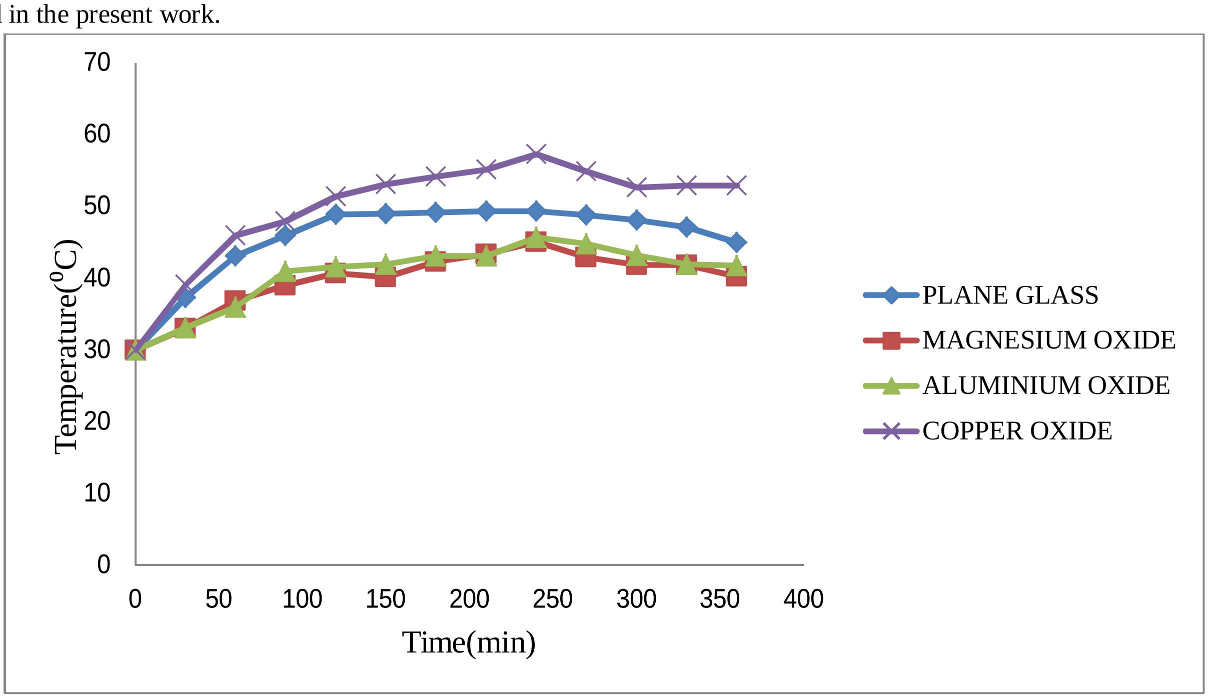


Figure 5 Comparison between time and temperature for 10 gm nanoparticles

When 10gm nanoparticles are mixed with adhesive and coated on the glass faces-
a) Plane glass: Maximum temperature: 49.4C and minimum temperature: $30^0$C.
b) Magnesium oxide nanoparticle: Maximum temperature: 44.7 $^0$C and minimum temperature: $30^0$C.
c) Aluminium oxide nanoparticle: Maximum temperature: $46.5^0$C and minimum temperature: $30^0$C.
d) Copper oxide nanoparticle: Maximum temperature: $55.9^0$C and minimum temperature: $30^0$C.
From the analysis of figure 5 it is clear that the solar heat gain in copper oxide is better than the other nanoparticles which have been used in the present work.

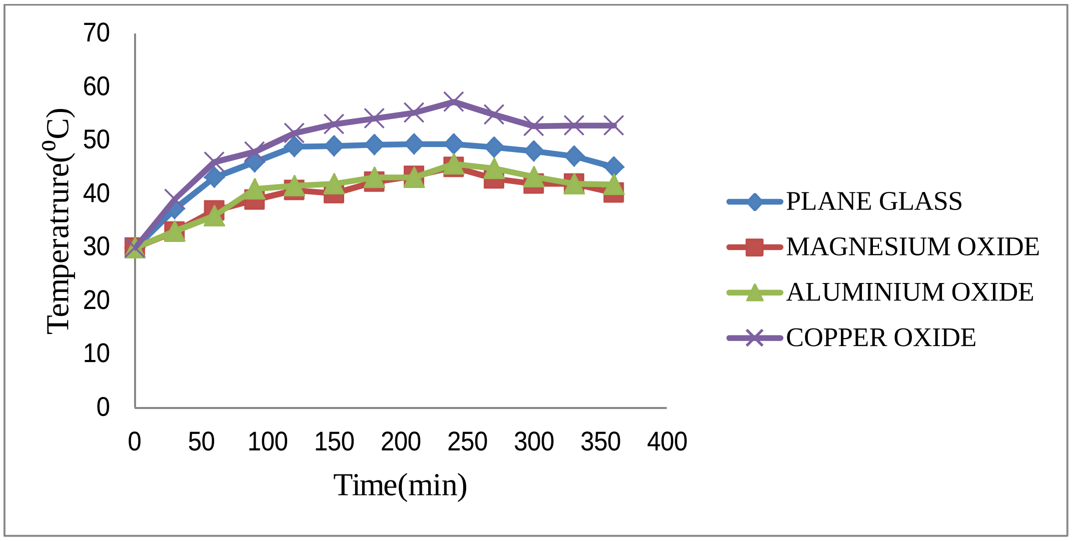


Figure 6 Comparison between time and temperature for 15gm nanoparticles

When 15gm nanoparticles are mixed with adhesive and coated on the glass faces-
a) Plane glass: Maximum temperature: 49.4C and minimum temperature: $30^0$C.
b) Magnesium oxide nanoparticle: Maximum temperature: $45.1^0$C and minimum temperature: $30^0$C.
c) Aluminium oxide nanoparticle: Maximum temperature: $45.7^0$C and minimum temperature: $30^0$C.
d) Copper oxide nanoparticle: Maximum temperature: $57.3^0$C and minimum temperature: $30^0$C.
From the analysis of figure 6 it is clear that the solar heat gain in copper oxide is better than the other nanoparticles which have been used in the present work.

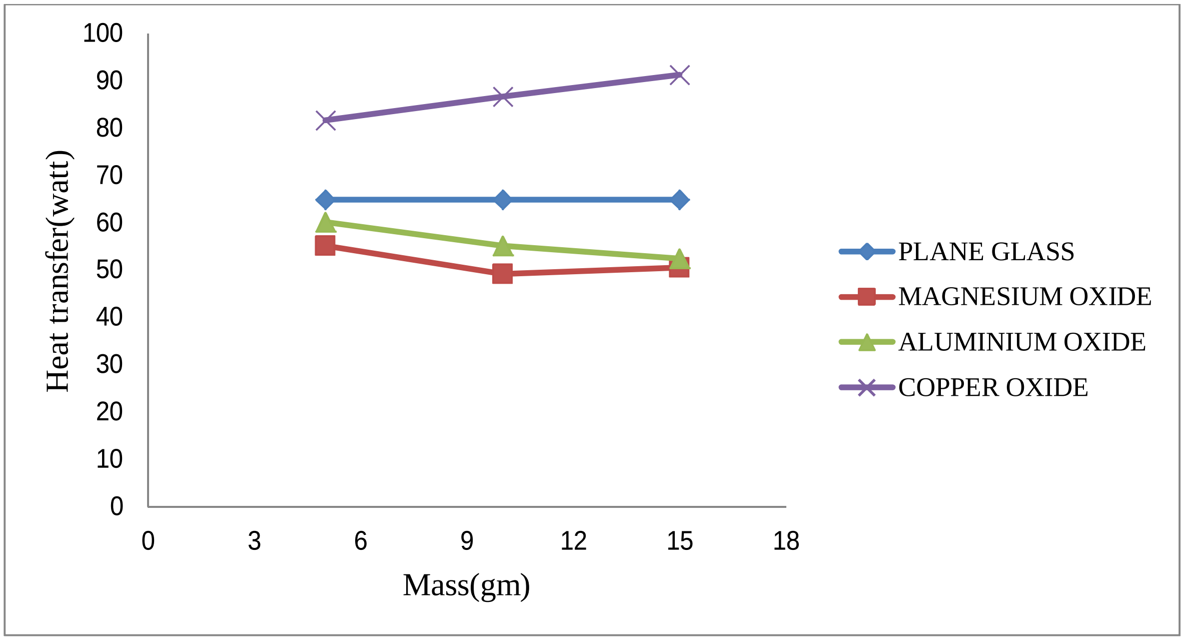


Figure 7 Comparison between solar heat gains in different test zones of different nanoparticles

From the analysis of figure 7 it is clear that the solar heat gain in copper oxide when all the nanoparticles are applied on the ratio of 5gm, 10gm and 15gm is better than the other nanoparticles which have been used in the present work.

## IV. CONCLUSION

This type of method is useful for maintaining the high room temperature (comfort temperature) for the places where outside temperature is very low throughout the year. The advantage of this method is that it is low cost exercise and it does not cause any harm to the environment. Here magnesium oxide nanoparticle, aluminium oxide and copper oxide nanoparticle are used for increasing the inside temperature in the test zone. It has been found that copper oxide nanoparticles applied test sections are better for maintaining comfort temperature.

## REFERENCES

[1] Types of glass and its engineering properties for use in construction https://theconstructor.org/building/types-of-glass-properties-uses-construction/14755/
[2] D.S.Kumar. Heat and Mass Transfer, S.K.Kataria and sons publisher, pp383-384.
[3] Sharma, A., Modi, O. P., & Gupta, G. K. (2012). Combustion Synthesis of Nanocrystalline Al2O3 Powder using Aluminium Nitrate and Urea as reactants—influence of reactant composition. Advances in Applied Science Research, 3(6), 3819-3824.
[4] Rajput, N. (2015). Methods of preparation of nanoparticles-A review. International Journal of Advances in Engineering & Technology, 7(6), 1806.
[5] Aruna, S. T., & Mukasyan, A. S. (2008). Combustion synthesis and nanomaterials. Current opinion in solid state and materials science, 12(3), 44-50.
[6] Kamalisarvestani, M., Saidur, R., Mekhilef, S., & Javadi, F. S. (2013). Performance, materials and coating technologies of thermochromic thin films on smart windows. Renewable and Sustainable Energy Reviews, 26, 353-364.
[7] Waters, M. A. (1986). U.S. Patent No. 4,623,497. Washington, DC: U.S. Patent and Trademark Office.
[8] O'Neal, D. P., Hirsch, L. R., Halas, N. J., Payne, J. D., & West, J. L. (2004). Photo-thermal tumor ablation in mice using near infrared-absorbing nanoparticles. Cancer letters, 209(2), 171-176.
[9] Wen, D., Lin, G., Vafaei, S., & Zhang, K. (2009). Review of nanofluids for heat transfer applications. Particuology, 7(2), 141-150.
[10] Chiras, D. D. (2002). The solar house: passive heating and cooling. Chelsea Green Publishing.
[11] Chen, B., Zhuang, Z., Chen, X., & Jia, X. (2007). Field survey on indoor thermal environment of rural residences with coupled Chinese kang and passive solar collecting wall heating in Northeast China. Solar Energy, 81(6), 781-790.
[12] Sun, B., Luh, P. B., Jia, Q. S., Jiang, Z., Wang, F., & Song, C. (2013). Building energy management: Integrated control of active and passive heating, cooling, lighting, shading, and ventilation systems. IEEE Transactions on automation science and engineering, 10(3), 588-602.
[13] Raman, P., Mande, S., & Kishore, V. V. N. (2001). A passive solar system for thermal comfort conditioning of buildings in composite climates. Solar Energy, 70(4), 319-329.
[14] Chen, W., & Liu, W. (2004). Numerical and experimental analysis of convection heat transfer in passive solar heating room with greenhouse and heat storage. Solar Energy, 76(5), 623-633.
[15] Balcomb, J. D., & McFarland, R. D. (1978). Simple empirical method for estimating the performance of a passive solar heated building of the thermal storage wall type (No. LA-UR-78-1159; CONF-780337-2). Los Alamos Scientific Lab., N. Mex.(USA).
[16] Krishan, A. (Ed.). (2001). Climate responsive architecture: a design handbook for energy efficient buildings. Tata McGraw-Hill Education.
[17] Majumdar, M. (Ed.). (2001). Energy-efficient buildings in India. The Energy and Resources Institute (TERI).
[18] Ekambaram, S., Patil, K. C., & Maaza, M. (2005). Synthesis of lamp phosphors: facile combustion approach. Journal of Alloys and Compounds, 393(1), 81-92.
[19] Sadabadi, H., Aftabtalab, A., Zafarian, S., Chakra, S., Rao, K. V., & Shaker, S. (2014). Influence of fuel and condition in combustion synthesis on properties of copper (II) oxide nanoparticle. In Advanced Materials Research (Vol. 829, pp. 152-156). Trans Tech Publications.

**APPENDIX:**

Table 2 Temperature reading when 5gm nanoparticles are mixed with adhesive

| TIME | PLANE GLASS | MAGNESIUM OXIDE | ALUMINIUM OXIDE | COPPER OXIDE |
|---|---|---|---|---|
| **0min** | $30^0C$ | $30^0C$ | $30^0C$ | $30^0C$ |
| **30min** | $37.3^0C$ | $33.9^0C$ | $33.9^0C$ | $38.1^0C$ |
| **60min** | $43.1^0C$ | $38^0C$ | $37^0C$ | $44.8^0C$ |
| **90min** | $46^0C$ | $40.9^0C$ | $41.1^0C$ | $47^0C$ |

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| | | | | |
|---|---|---|---|---|
| **120min** | 48.9$^0$C | 41.9$^0$C | 42.1$^0$C | 49.1$^0$C |
| **150min** | 49$^0$C | 42.7$^0$C | 42.1$^0$C | 51.9$^0$C |
| **180min** | 49.2$^0$C | 44.1$^0$C | 44.5$^0$C | 54$^0$C |
| **210min** | 49.4$^0$C | 46.5$^0$C | 46.3$^0$C | 54.4$^0$C |
| **240min** | 49.4$^0$C | 45.1$^0$C | 48$^0$C | 52.8$^0$C |
| **270min** | 48.8$^0$C | 44.3$^0$C | 47.3$^0$C | 51$^0$C |
| **300min** | 48.1$^0$C | 42.1$^0$C | 44.8$^0$C | 50.3$^0$C |
| **330min** | 47.1$^0$C | 41.9$^0$C | 43.5$^0$C | 50.3$^0$C |
| **360min** | 45$^0$C | 41.7$^0$C | 42.9$^0$C | 51.1$^0$C |

Table 3 Temperature reading when 10 gm nanoparticles are mixed with adhesive

| TIME | PLANE GLASS | MAGNESIUM OXIDE | ALUMINIUM OXIDE | COPPER OXIDE |
|---|---|---|---|---|
| **0min** | 30$^0$C | 30$^0$C | 30$^0$C | 30$^0$C |
| **30min** | 37.3$^0$C | 33.1$^0$C | 33.3$^0$C | 38.8$^0$C |
| **60min** | 43.1$^0$C | 37.1$^0$C | 36.7$^0$C | 45.2$^0$C |
| **90min** | 46$^0$C | 41$^0$C | 40$^0$C | 47.1$^0$C |
| **120min** | 48.9$^0$C | 41.5$^0$C | 41.7$^0$C | 49.9$^0$C |
| **150min** | 49$^0$C | 41.7$^0$C | 42.1$^0$C | 52.7$^0$C |
| **180min** | 49.2$^0$C | 44.3$^0$C | 42.1$^0$C | 52.9$^0$C |
| **210min** | 49.4$^0$C | 44.7$^0$C | 44$^0$C | 53$^0$C |
| **240min** | 49.4$^0$C | 44.7$^0$C | 46.5$^0$C | 55.1$^0$C |
| **270min** | 48.8$^0$C | 42.2$^0$C | 44.8$^0$C | 55.9$^0$C |
| **3[illegible]** | [illegible] | [illegible] | [illegible] | 52.[illegible] |
| **330min** | 47.1$^0$C | 41.1$^0$C | 42.1$^0$C | 52.1$^0$C |
| **360min** | 45$^0$C | 40.9$^0$C | 42.1$^0$C | 52$^0$C |

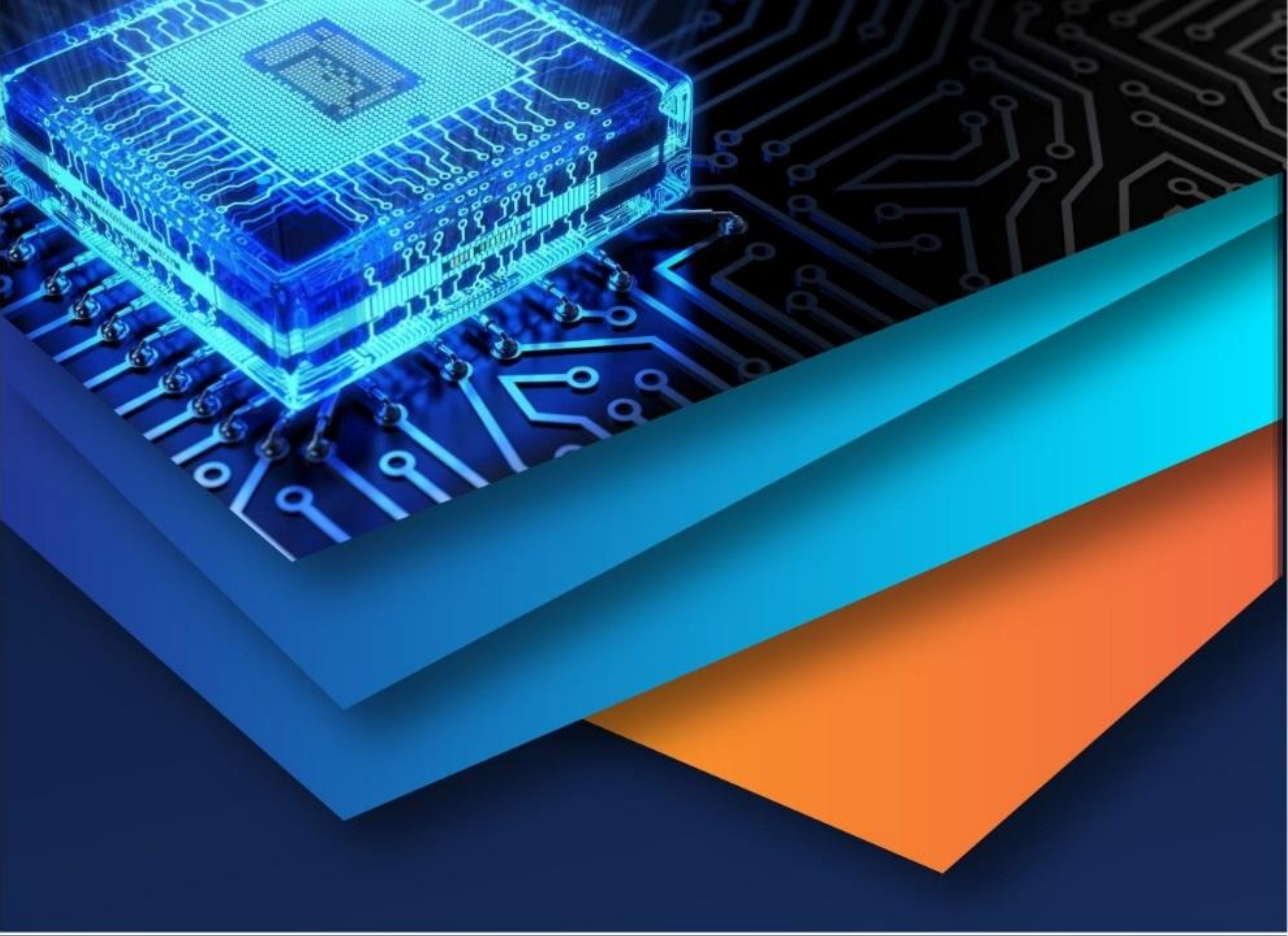
Table 4 Temperature reading when 15 gm nanoparticles are mixed with adhesive

| TIME | PLANE GLASS | MAGNESIUM OXIDE | ALUMINIUM OXIDE | COPPER OXIDE |
|---|---|---|---|---|
| **0min** | 30$^0$C | 30$^0$C | 30$^0$C | 30$^0$C |
| **30min** | 37.3$^0$C | 33$^0$C | 33.1$^0$C | 39.1$^0$C |
| **60min** | 43.1$^0$C | 36.9$^0$C | 36$^0$C | 46$^0$C |
| **90min** | 46$^0$C | 39$^0$C | 41$^0$C | 47.9$^0$C |
| **120min** | 48.9$^0$C | 40.7$^0$C | 41.6$^0$C | 51.4$^0$C |
| **150min** | 49$^0$C | 40.2$^0$C | 42$^0$C | 53.1$^0$C |
| **180min** | 49.2$^0$C | 42.3$^0$C | 43.1$^0$C | 54.2$^0$C |

| | | | | |
|---|---|---|---|---|
| **210min** | 49.4$^0$C | 43.4$^0$C | 43.1$^0$C | 55.2$^0$C |
| **240min** | 49.4$^0$C | 45.1$^0$C | 45.7$^0$C | 57.3$^0$C |
| **270min** | 48.8$^0$C | 42.9$^0$C | 44.8$^0$C | 54.9$^0$C |
| **300min** | 48.1$^0$C | 41.9$^0$C | 43.2$^0$C | 52.7$^0$C |
| **330min** | 47.1$^0$C | 41.9$^0$C | 42$^0$C | 52.9$^0$C |
| **360min** | 45$^0$C | 40.3$^0$C | 41.8$^0$C | 52.9$^0$C |

Table 5 Heat

| **NANOPA** |
|---|
| PLANI |
| MAGNES |
| ALUMINI |
| COPPE |

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