

Dr. M Shahnawaz Khan, Mr Sivi, Mr Meet, Mr Amal  
Fire Safety Engineering & Management Department  
RG-TRC

Research Day-25

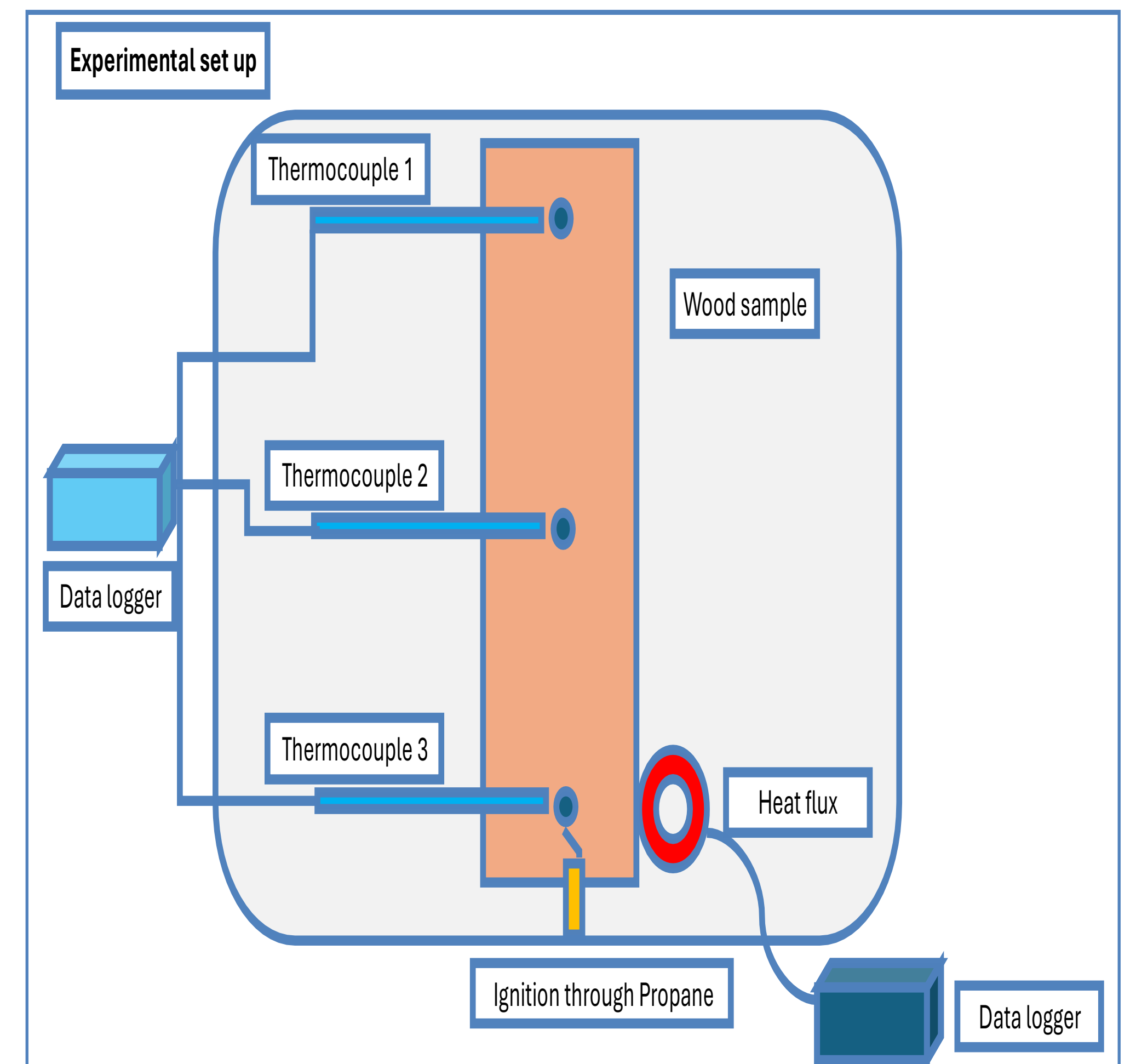
## Abstract

To study the potential resistance of fire, using ZnO nanoparticles mixed in wood paint would eventually not only reduce the resistance against the fire but also reduce the smoke density. Various experiments were conducted to investigate the behavior of different concentration of nanoparticles impact on the commercial wood which is used in the furniture industry. Ignitibility test by UL-94 standard was conducted by employing propane at 450C on the vertical wood holder in the clamp. Thermocouples were also attached in three different locations to record the change in the temperature. Infrared camera was employed to take thermal images at various locations at different intervals of time. Mass loss rates and microscopic images were taken to investigate the fire resistance behavior of mixture of wood paint and nanoparticles.

## Methods and Materials

An adjustable burner assembly, mounted on running rails, to enable the small premixed flame to be tilted at an angle of 45° to the specimen and offered to it in one fluid movement. The test takes place inside a test chamber where the test specimen is mounted vertically. The test specimen is subjected to edge and/or surface exposure from a gas flame. During the test, time of ignition, burning droplets and whether the flames reach the top marking of the test specimen within a prescribed time period, is recorded. The FLIR, Ex series cameras are compact and rugged infrared cameras that can be used in harsh environments while still provide with the latest technology such as a modern touch screen and wireless connectivity.

## Schematic



## Introduction

Due to the advancement in the commercial building industry and upgrading of economics of people. They want the dwelling place to be more beautiful, durable, and cost effective. But these all requirements cannot be met without any additional treatments, these items make the living place more vulnerable to fire accidents. They need to be followed the safety requirements set by NFPA, BS, GCC standards etc (1). Wood without treated is highly susceptible to ignite, therefore some mechanism should be there to make the wood more fire resistant. Nanotechnology is a field which can easily make it high fire resistant. By using the nanotechnology in building materials like coating, steel, clay composite, concrete, insulation etc. Although the demand of nanomaterials is not very high, but requirement will grow due to global and economic growth of the people(2). Due to smaller size of NPs which are in the range of nanometer, they are use in various applications related to biological, chemical etc. Adding of NPs significantly increases the fire resistance in the construction materials by varying their size, shape, morphology, thermal resistance, functional groups (3). They are further divided based on their morphology one-dimensional, two-dimensional and three-dimensional.

## Results

The reason for the high burning rate is the combustion gases going upward with the wood sample. The convective heat transfer rate of burning facilitates the high temperature of gas in the remaining portion of wood sample. The material, which is thin and combustible, may have a high chance of burning fast and their critical temperature of pyrolysis and gasification is usually small, which causes the wooden sample to burn fast(4). Initially, the flame height, temperature and heat flux are less, but due to convective heat transfer, these phenomena increase later. Combustion in the wood particularly ignitibility, flame spread, heat release can be delayed by using the fire-retardant material. One of the processes by which fire retardants act is the formation of a char layer after attaining high temperature and ceasing the availability of oxygen to wood.

## Discussion

It may be due to the effect of catalyzing carbonization, as it formed a thick layer around the flame zone physical barrier role. As there is a more char layer formation, which controls spread of heat and enhances the flame retardancy.

Combustion is a complex process where various factors play a role in burning. During combustion, there is a formation of sinter, which increases the resistance due to its mass, thermal barrier effect, labyrinth effect, steric and catalytic effect (5).

According to the thermal barrier effect the nanomaterials do not infuse into sinter layer, which helps in further resistance to fire. Also, nanomaterials infuse with some of the burning products and reduce the combustion further (6-8). The combustion of the nanomaterials is further reduced through the thermal barrier effect, where the sinter layer accommodates on the surface of the nanomaterials which reduces the weight loss and access to oxygen during the combustion.

## Conclusions

Ignitibility test by UL-94 standard was conducted by employing propane flame at 45° on the vertical wood holder in the clamp. Thermocouples were also attached in three different locations to record the change in the temperature. Infrared camera was employed to take thermal images at various locations at different intervals of time. Placing the heat flux near to wooden clamp gives an idea of how much heat is generated for different concentrations of nanoparticles.

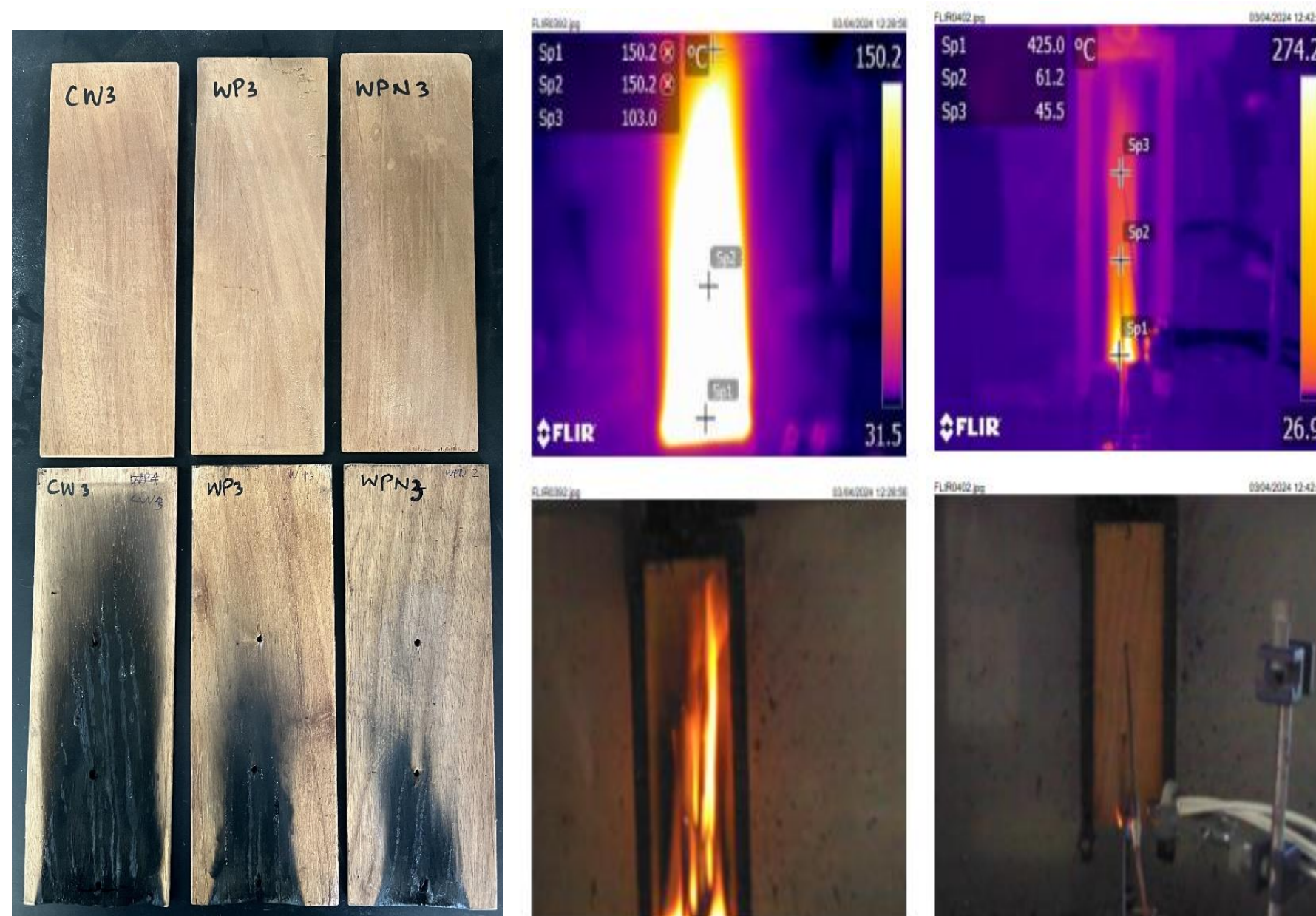


Figure 1. Pine wood before and after burn along with IR photo .

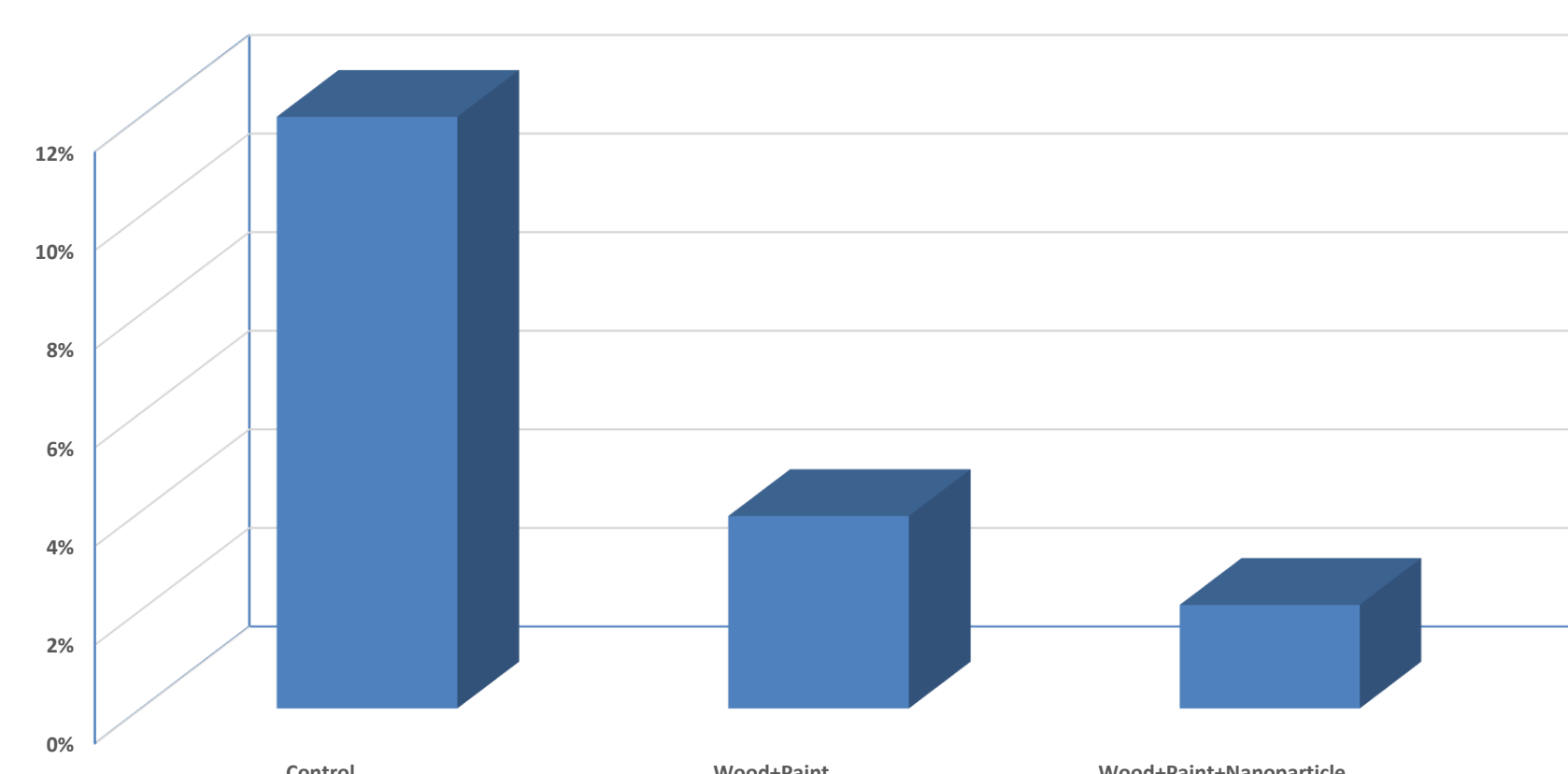
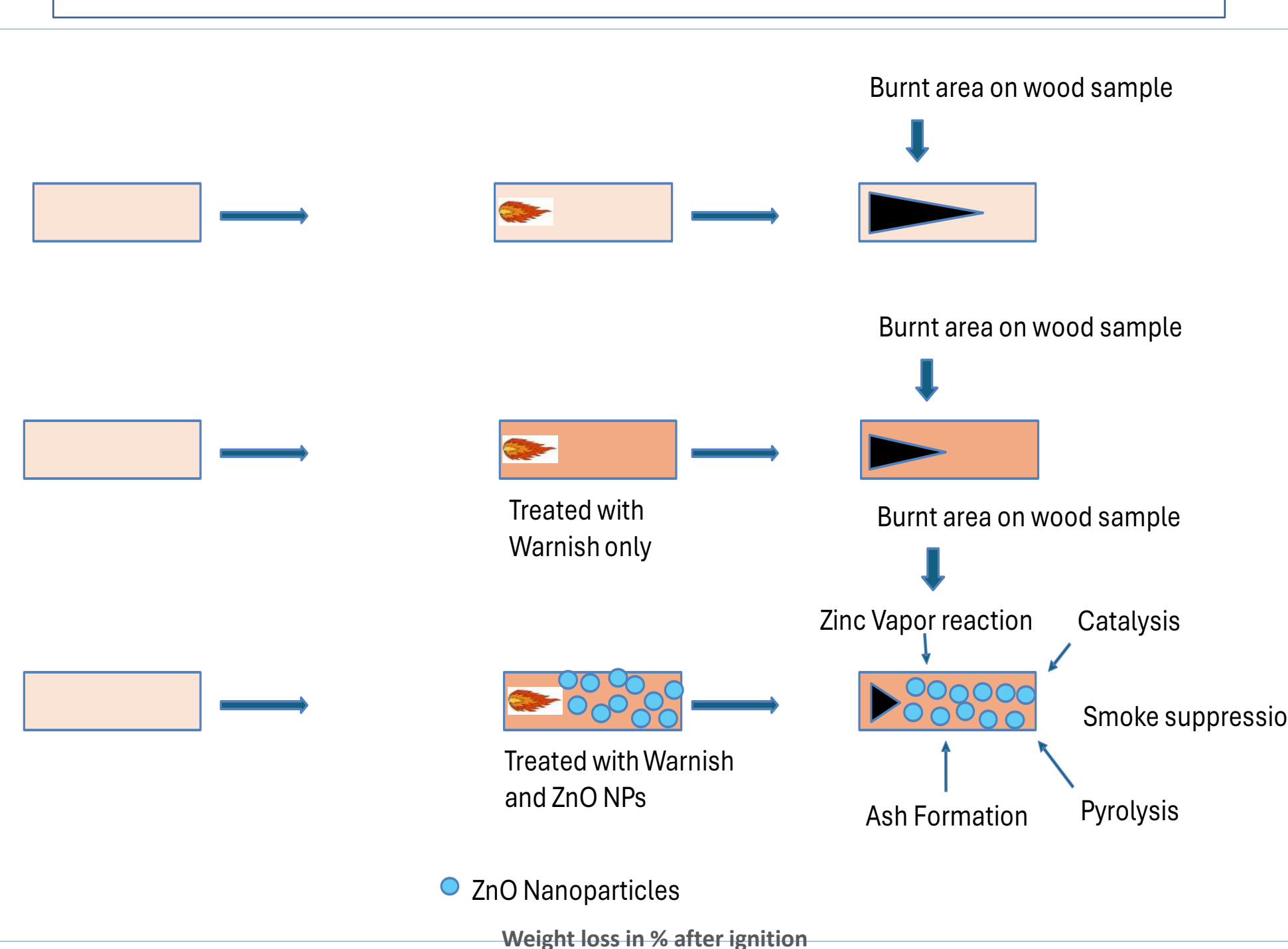


Figure 2. Mass loss of pine wood after treatment with ZnO NP

## Contact

Dr. M Shahnawaz Khan

99637862

shahnawaz@icem.edu.om

Dept of Fire Safety Engineering and Management,

International College of Engineering and Management, Muscat, Oman

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