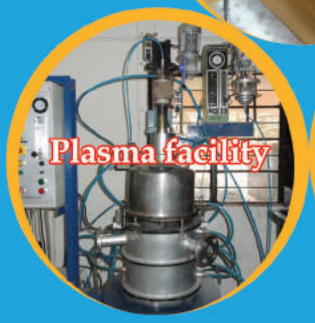
# CENTRE FOR RESEARCH IN MATERIAL SCIENCE AND THERMAL MANAGEMENT

## DEPARTMENT OF MECHANICAL ENGINEERING



- Facilities
- Testing
- Consultancy

**Karunya Institute of Technology & Sciences**

Declared as Deemed-to-be University under Section-3 of the UGC Act, 1956

# Karunya Founders

The late Dr. D.G. S. Dhinakaran, C.A.l.l.B., Ph.D., the Founder Chancellor Emeritus of Karunya Institute of Technology and Sciences, was a world renowned spiritual leader, accepted by people of all faiths and leaders of many nations. He is the founder of the global Jesus Calls Ministry of which Karunya is just an offshoot. Millions of people all over the world receive hope and solace through his ministry. His vision for Karunya is that of a Technological University founded on faith that will produce teachers, engineers and managers possessing the right combinations of academic excellence, exemplary character and total humanism. The aim is to serve the motherland and fellow men and help raise the quality of life to global standards.

Dr. Paul Dhinakaran, M.B.A., Ph.D., the Chancellor of Karunya Institute of Technology and Sciences spearheads the University. He is an academician and educationalist in his own right. Apart from this he is an evangelist who comforts millions through his ministry of hope and love. He heads Jesus Calls International Ministry with its outreach program all over the world. Dr. Paul Dhinakaran has a vital role to play in the cause of education in India as Member of National Monitoring Committee for Minority Education,Government of India and as member of the Governing Council of National Mission for Sarva Shiksha Abhiyan, Government of India.

# Preface

Thermal management of systems, especially those of electronics has assumed great importance of late due to the widespread use of computers and microprocessor based control systems. The primary factor which governs the efficiency of the system is the processor speed which is a direct function of the packing density. As shown by the popular Moore's law, this packing density is constantly rising for the processors. However, this increased speed is realized at the cost of a corresponding rise in heat generation which tends to heat up the electronic components. If not controlled appropriately, this increased temperature rise will lead to failure of the electronic component and ultimately to system failures.

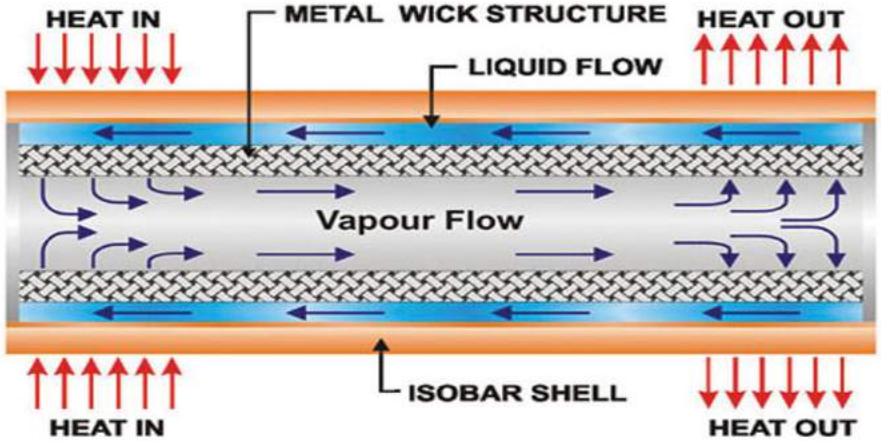
The above scenario has led to intensified attempts worldwide on the subject of thermal management. While for special applications, refrigerated systems could be used, for cooling of a number of electronic products, the ambient air itself could be made use of as the coolant through a mechanism by which the heat generated at source is transported to a point where cooling by ambient air could take place.

Heat pipes play a very important role in the above mechanism of transporting heat from the source to sink in a passive manner, which has led to its development primarily in satellite cooling application. Due to the fact that satellites are not possible to be repaired or serviced during their operation, the use of the heat pipe has been an unqualified success in aerospace applications. However, today the application of heat pipe is not only limited to the aerospace field, but is widespread in terrestrial applications as well, such as in manufacturing, machine tools, biomedical equipment and a host of others which involve electronics and computers.

Karunya Institute of Technology and Sciences has been a pioneer in the field of heat pipe research and development among the engineering institutions of the country. It has a well established laboratory where various types of heat pipes, including thermosyphon, pulsating heat pipes, heat spreaders and a host of other variants of the system are being developed by researchers. This brochure is a short overview of these facilities and activities.

# Heat Pipe Research Facilities

A heat pipe is a simple device that can quickly transfer heat from one point to another. Heat pipes can be bent and flattened into a variety of geometries making them ideal for removing heat from high power densely packed electronics.

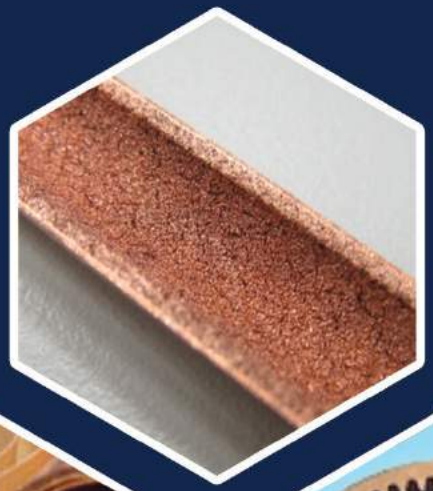



## Applications

Heat pipes are used as a cooling device in many industrial applications such as mould cooling, electronic packages cooling, space cooling and reactor cooling etc. Also, heat pipes are used as a heat transfer device in ventilation, heat recovery and solar thermal applications.

## Features

- High heat conductivity
- Fast thermal response
- Uniform temperature distribution
- Light weight & compact
- High design possibilities
- No aditional power required
- Maintenance free
- No moving parts



Sintered wick

Screen wick

Grooved wick

# Helium Leak Detector


## Applications

Mass spectrometer leak detector is used for locating and measuring the size of the leak at an enclosure. This equipment can be utilized to ensure the necessary vacuum condition in the heat pipes and vapor chambers.

# Vacuum Pumping System


## Specifications

| | |
|---|---|
| Model | : HMS-P-100L |
| Make | : Hindivac |
| Type | : Double stage rotary pump |
| Pump model | : ED-6 |
| Pump displacement | : 6 m3/hr |
| Power | : 220 V Ac, 50 Hz |
| Oil charge | : 2 lts |

## Accessories

- Liquid nitrogen trap
- Roughing valves
- Backing valves
- Throttle valves
- Double stage rotory pump

## Features

- Short response and clean-up time
- Laminated top for clean work space
- $LN_2$ Trap holds charge for 12 hours
- Easy to operate
- Wheels with movable system

## Applications

The vacuum pumping unit is used to maintain the necessary vacuum condition in the heat pipe and vapor chamber. These systems are also suitable for most of the vacuum applications and low pressure vaporization applications etc.,

# Vacuum Pumping System...

## Specifications

| | |
|---|---|
| Model | : Vs-65D |
| Make | : Hindivac |
| Range | : Max $10^{-4}$ milli bar |
| Pump model | : ED-6 |
| Pump displacement | : 6 $m^3$/hr |
| Oil charge | : 2 lts |

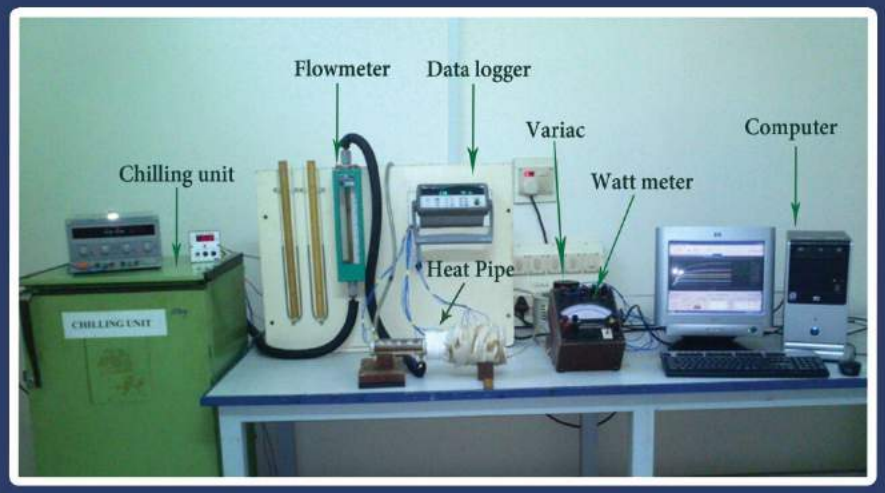
## Accessories

- Liquid nitrogen trap
- Water cooled chevron baffle
- Electro pneumatically operated valve (Butterfly valve, right angle valve)
- Push buttons

## Features

- All components easily accessible
- Compact construction
- Simple operation
- Allows direct connection of vacuum chamber
- Pumping speed ranging from 120 lps

# Heat Pipe - Experimental Set-up




## Applications

This experimental facility is used to evaluate the heat transfer performance of different types of heat pipes such as cylindrical heat pipes, loop heat pipes, pulsating heat pipes and vapor chambers.

Miniature heat pipe

Vapor chamber

Flat loop heat pipe

# Rotating Heat Pipe Research Facilities

## Applications

Fabrication and testing of rotating heat pipes are also carried out in the centre. Generally, the rotating heat pipes are used to cool the compressor shafts, drill bits and machine tools etc. Also, it is used in heat recovery systems in various rotary equipment.

Aluminum heat pipe

Cylindrical loop heat pipe

Pulsating heat pipe

# Plasma Research Facilities

## Specifications

| | |
|---|---|
| Make | : Ion-Arc Technologies |
| Power input | : Max 40 kW |
| Voltage | : 40 V |
| Current | : 800 A |
| Torch type | : Transfered |
| | : Non -Transferred |

## Applications

This facility is used to seperate the minerals from the ore material. Also, used to make plasma spray coatings and carbothermal reductions.

## Accessories

Mass flow controller

Powder feeder

Torch

Graphite crucible

Argon, nitrogen cylinder

Transferred arc

Non - transferred arc

# Heat Flux Sensor Calibration Facilities

Black Body Cavity

## Specifications

| | |
|---|---|
| Make | : MIKRON |
| Model | : M350 |
| Temperature range | : 300 °C to 1500 °C |
| Power input | : 208-230 V Ac, 60/50 Hz |
| Cooling method | : Air cooled |
| Heated cavity shape | : Spherical |
| Method of Control | : Digital self - tuning PID controller |
| Operating ambient temperature | : 0 °C to 44 °C |
| Stability | : 0.5 °C per 8 hour period |
| Emissivity | : 0.999 |

## Applications

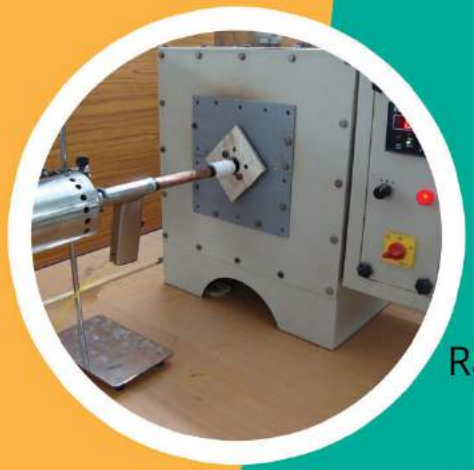
This facility is used to calibrate and test the heat flux sensors.

# Black Body Heat Source

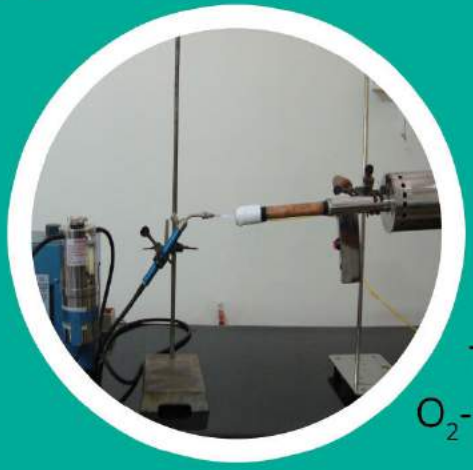
## Specifications

| | |
|---|---|
| Range | : 50 °C to 500 °C |
| Target size | : 57 mm |
| Resolution | : 0.1 °C |
| Heating time | : 30 min (50 °C to 500 °C) |
| Cooling time | : 30 min (500 °C to 100 °C) |
| Stabilization time | : 10 min |
| Power | : 115 V Ac, 3 A or 230 V Ac, 1.5 A |
| Target emissivity | : 0.95 |

Testing with
Heat flux sensors



Testing with
Radiant heat source



Testing with
$O_2$-$H_2$ micro flame

# Gas Chromatograph System

## Features

High performance

Highest precision and accuracy

Easy operation and flexibility

Expandability to support all types of analysis

## Specifications

| | |
|---|---|
| Model | : GC - 2014 |
| Make | : Shimadzu |
| Temperature range | : Max 400 °C |
| Power requirements | : 1800 VA, 50/60 Hz |
| Oven capacity | : 15.8 L |
| Cooling rate | : 300 °C to 50 °C in 6 min |

## Accessories

Carrier gas flow controller

Flame ionization detector

Thermal conductivity detector

Flame ionization detector

# Gas Chromatograph System...

## Applications

The gas chromatograph systems are used for quantitative and qualitative analysis of both liquid and gas samples.

Seperating and analysing compunds that can be vapourized without decomposition.

FID measures organic species in a sample mixture at very low and high levels of concentrations.

TCD measures both organic and inorganic compounds concentrations and it is equiped with shin corbon column for simultaneous analysis of inorganic gases like $H_2$, $O_2$, CO, $CH_4$, $CO_2$, $N_2O$, $C_2H_2$, $C_2H_4$ and $C_2H_6$

# Nanofluid Research Facilities


Tensiometer

## Applications

The tensiometer is used to measure the surface tension of liquids at the plant or in the laboratory. Also, this device is used to maintain the surfactant concentration in industries.

# Tensiometer...

## Specifications

| | |
|---|---|
| Measuring range | : 10-100 mN/m |
| Resolution | : 0.1 mN/m |
| Bubble lifetime | : 150-2000 ms |
| Resolution | : 1 ms |
| Temperature range | : 0-100 °C |
| Power supply | : 100 - 240 V |
| | : 47 - 63 Hz |

## Specifications

| | |
|---|---|
| Model | : LVDV-E |
| Viscosity range | : Max 100 Cp |
| | : 18 spindle speeds |
| RPM | : 0.3-100 |
| Spring torque | : 0.0673 mN/m |
| Accuracy | : 0.1% of full scale |
| Repeatability | : 0.2% of full scale |

## Viscometer


## Applications

The viscometer is used to measure the viscosity of fluids. Such as water, nanofluid and oils at varying temperature.

# Ultrasonic Homogenizer

## Specifications

| | |
|---|---|
| Model | : CY-500 |
| Make | : J P Selecta, Spain |
| Power | : 500 W |
| Frequency | : 20 kHz |

## Applications

This equipment is used to prepare various types of nanofluids by suspending ultrafine metallic particles in to the base fluid. Also, this equipment is used to disintegrate the cells and biological tissues etc.

Ultrasonic homogenizer
(CY-500)

# Thermal Property Analyser

## Specifications

| | |
|---|---|
| Model | : KD2 Pro-40348 |
| Temperature range | : 25-50 °C |
| Accuracy | : ± 2% |
| Types of sensors used | : KS-1, TR-1, SH-1 |


Thermal property analyser
(KD2 Probe)

## Parameters

Thermal conductivity

Specific heat of liquids

Thermal resistivity of slurries and semi solids.

# Drop shape analyzer

Make : KRUSS GmBH

Range : 0-180o

Pendent Drop Range :0.01 to 2000 mN/m

## TASKS AND APPLICATIONS

- Characterization of surface pre-treatment processes.
- Testing of the wettability of plastic, glass, ceramic, wood, paper, textiles or metal.
- Testing of surface cleanliness.

Drop shape analyzer

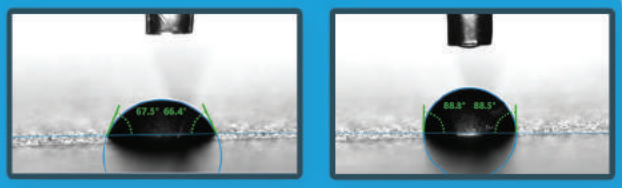
## Measuring methods and options

Contact angle between a liquid and a solid

Surface free energy from contact angles of several test liquids using all common models

Static contact angle, advancing angle and receding angle

Measurement of surface tension and liquid-liquid interfacial tension using the Pendant Drop method



Contact angle measurement

# Coating Thickness Tester


## FEATURES

Make : Metrix +

Model : DFT-F

Range : 0 to 1250 µm

Resolution : 0.1 µm

Temperature Range : 0-50 °C

Humidity : < 80%

# 3D PRINTER

## APPLICATION

printing of any material in 3-dimention.

## Product Features

Removable magnetic spring steel sheet with PEI surface.

Silent Trinamic drivers with 256 microstepping.

Faster printing: 200+ mm/s.

Sensorless homing for X and Y axes.

Detection and recovery of shifted layers.

Improved frame rigidity with aluminium extrusions.

Better cooling from both sides of the object.

Prusa i3 MK3

# HIGH SPEED CAMERA (CHRONOS 1.4)

## Highlights

- 1280×1024 1057fps CMOS image sensor with 1.4Gpx/s throughput
- Global shutter LUX1310 image sensor – 8.45 x 6.76mm, 6.6um pixel pitch
- Electronic shutter from 1/fps down to 2us (1/500,000 s)
- Focus peaking (focus assist) and zebra exposure indicator
- ISO 320-5120 (Color), 740-11840 (Monochrome)


Chronos 1.4

## APPLICATION

professional high-speed camera in the palm of your hand.

With 1.4 gigapixel-per-second throughput and cancapture stunning high-speed video at up to 1280x1024 resolution.

Frame rate ranges from 1,057fps at full resolution, up to 21,600fps at minimum resolution..

# FOR FURTHER DETAILS, QUERIES OR CLARIFICATIONS PLEASE CONTACT

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## Other Research Centres

Renewable Energy

Metallurgy

Design and Manufacturing

# Programmes Offered

- B.Tech. Mechanical Engineering.
- M.Tech. Engineering Design.
- Ph. D Programmes in the above areas.

Centre for Research in Material Science and Thermal Management, School of Mechanical Sciences
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