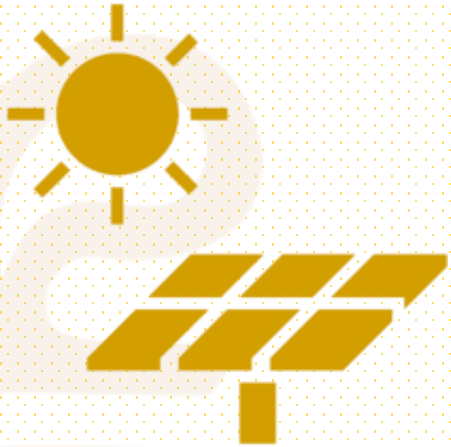
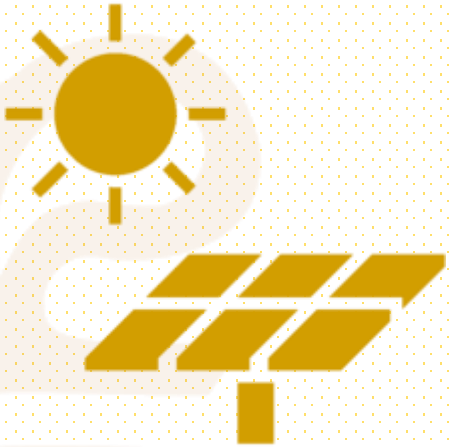
ADVANCED MATERIALS LABORATORY

Analytical and non-analytical instruments



ANALYTICAL INSTRUMENTS

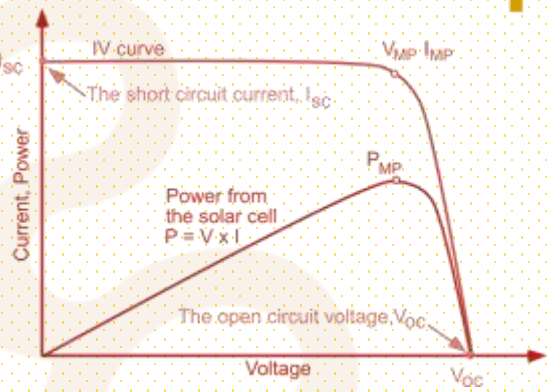


Shiraz University, Department of Materials Science and Engineering

I-V tracer

Introduction

The **IV curve** of a solar cell is the superposition of the IV curve of the solar cell diode in the dark with the light-generated current. The light has the effect of shifting the IV curve down into the fourth quadrant where power can be extracted from the diode. Illuminating a cell adds to the normal "dark" currents in the diode so that the diode law becomes:



Typical current-voltage and power-voltage curves of a solar panel

$$I = I_0 \left[exp\left(\frac{qV}{nkT}\right) - 1 \right] - I_L$$

Where I_L is light generated current. The power curve has a maximum denoted as P_{MP} where the solar cell should be operated to give the maximum power output. The short-circuit current and the open-circuit voltage are the maximum current and voltage respectively from a solar cell. However, at both of these operating points, the power from the solar cell is zero. The "fill factor", is a parameter which, in conjunction with V_{oc} and I_{sc}, determines the maximum power from a solar cell.

$$FF = \frac{P_{MP}}{V_{oc} I_{sc}}$$

Device: I-V tracer

Manufacturer: *SHARIF SOLAR*

This lab is equipped with a IV tracer which measures the I-V curve corresponding to the function of the solar cell panel, based on which I_{sc}, V_{oc}, V_{MP}, I_{MP}, P_{max} , and FF may be found.

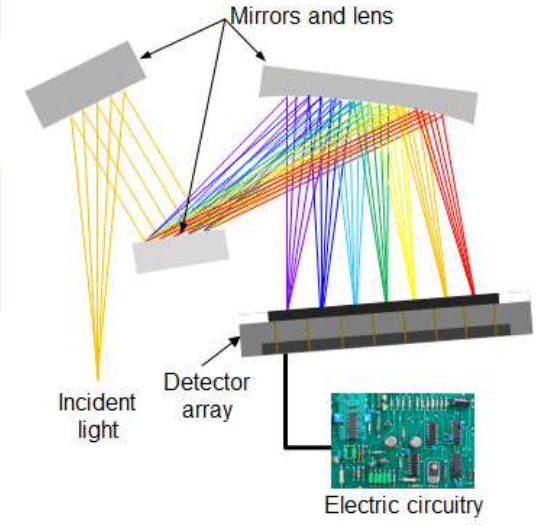
Technical specifications

Potential range (adjustable)	**±5 V / ± 1 V**
Potential resolution	**%0.025 of Scale**
Voltage set resolution	**%0.025**
Maximum current	**1A**
Current range	
Course current range	**100 nA-1A (8 steps)**
Fine current range	**Full scale (FS)/2, FS/4, FS/8**
Current resolution	**0.0005% (of current range)**
Min. current resolution	**50 pA**
Sample rate	**1000 S s-1**
Input impedance	**100 MOhm**
Input voltage	**100-240 V AC (50-60 Hz)**
Computer interface	**USB**

Fiber optic spectrometer

Introduction

Spectroscopy is a technique for measuring the intensity of light in the ultraviolet, visible, near-infrared and infrared wavelengths. Fiber optic spectrometer usually uses optical fiber as signal coupling devices to couple the measured light into the spectrometer for spectral analysis. Portable spectrometer is the main component of optical instruments. This technique poses the advantages of high detection accuracy, high detection speed, modularity, flexibility of the measurement system. Spectroscopic measurements are used in a wide variety of applications, such as color measurement, concentration detection of chemical components, electromagnetic radiation analysis, agriculture, biology, chemistry, geology, food safety, chromaticity calculation, environmental testing, medicine and health, LED testing, semiconductor industry, and petrochemical industry.



Schematic presentation of the function of light spectrometer

Device: Fiber optic spectrometer

Manufacturer: *OCEAN OPTICS/S2000*

This lab is equipped with a fiber optic spectrometer, responsive from 200-1100 μm, with the following specifications.

Technical specifications

Focal length (input)	**42 mm**
Focal length (output)	**68 mm (75, 83 and 90 mm focal lengths are also available for some configurations)**
Gratings	**14 different gratings**
Entrance slit:	**5, 10, 25, 50, 100, or 200 μm slits. (Slits are optional. In the absence of a slit, the fiber acts as the entrance slit.)**
Integration time	**3 – 65,000 msec**
Dynamic range:	2×10^8
Readout noise	**250:1 single acquisition (single dark spectrum)**
Signal-to-Noise	**3.5 counts RMS, 20 counts peak-to-peak**
Resolution (FWHM)	**0.3 – 10.0 nm varies by configuration**
Stray light	**<0.05% at 600 nm; <0.10% at 435 nm**

Device: Multifunctional bench meter

Manufacturer: *ADWA/AD8000*

This lab is equipped with a microprocessor-based multifunctional bench meter capable of measurement of pH, Oxidation Reduction Potential (ORP), Electric Conductivity (EC), Total Dissolved Solids (TDS), and temperature of solutions with several probes. It has also the feature of auto-ranging EC and TDS which sets the instrument to the scale with the highest resolution. Additionally, pH and EC measurements can be compensated automatically for temperature effect. However, it is also possible to disable the temperature compensation and measure the actual conductivity.

Device: Multifunctional bench meter

Manufacturer: *ADWA/AD8000*

Technical specifications

-2.00 to 16.00 pH /-2.000 to 16.000 pH

±699.9 mV / ±2000 mV

0.00 to 19.99 µS/cm; 0.00 to 9.99 ppm

20.0 to 199.9 µS/ cm; 10.0 to 99.9 ppm

200 to 1999 µS/cm; 100 to 999 ppm

2.00 to 19.99 mS/cm; 1.00 to 9.99 ppt

0.0 to 199.9 mS/cm; 10.0 to 99.9 ppt

-9.9 to 120.0 °C (pH range)

0.0 to 100.0°C (EC range)

Resolution

0.01 pH / 0.001 pH

0.1 mV (±699.9 mV) / 1 mV (±2000 mV)

0.01, 0.1, 1 µS/cm; ppm

0.01, 0.1 mS/cm; ppt

0.1°C

Accuracy (@25°C)

± 0.01 pH / ± 0.002 pH

± 0.2 mV up to ± 699.9 mV ± 1 mV up to ± 2000 mV

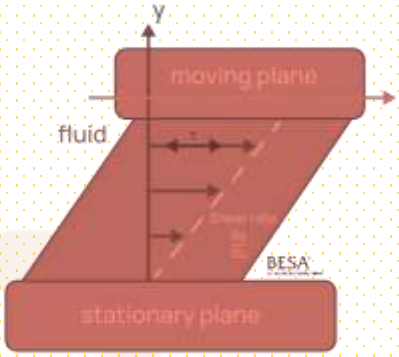
± 1% f.s. (EC/TDS)

± 0.5°C

Viscometer

Introduction

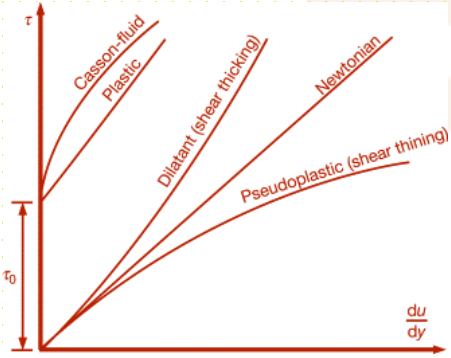
In simplest terms, viscosity is defined as “the resistance to flow” and is often referred to as the thickness of a fluid. When a shear force is acted upon a constrained film of a liquid, a velocity distribution would be developed as shown. Newton first considered this problem and assumed that a following relation to be exist between the applied shear stress and the developed velocity distribution:



Developed velocity gradient in a fluid subjected to shear stress

$$\tau = \eta \, {}^{\partial v}/_{\partial y}$$

Where τ is the applied shear stress, η is the viscosity, v is the velocity in the direction of the applied shear stress, and y is the distance perpendicular to the applied shear.



Viscosity, itself, may be a function of the applied shear rate, therefore it is of scientific and practical importance that the apparatus used for measuring the viscosity of the desired fluid, allows the measurement to be made under various shear rates.

$\tau - du/dy$ curves corresponding to different materials indicating the ways by which viscosity may be affected by the shear rate

Device: Viscometer

Manufacturer: *BROOKFIELD RVDV-II + PRO*

This lab is equipped with a viscometer which can be used to track the changes in the viscosity of the desired fluids under different shear rates. The principals of the operation of this device includes the rotation of a cylinder after being immersed in the sample container according with the desired speed, and measurement of the required torque.

Technical specifications

Viscosity Range (cP)	**100 - 40,000,000**
Temperature Sensing Range	**-100˚C to 300˚C (-148˚F to 572˚F)**
Viscosity Accuracy	**±1.0% of full scale range**
Viscosity Repeatability	**±0.2% of Full Scale Range**
Temperature Accuracy	**±1°C | -100°C to +149°C**
	±2°C | +150°C to +300°C
Operating Environment:	**0 °C to 40 °C temperature range (32°F to 104°F)**
	20% - 80%R.H.: non-condensing atmosphere

Device: Shore D hardness test machine

Manufacturer: *SANTAM*

The Shore D Hardness test (also called Durometer Hardness Test) is used when the material is too soft to be measured by a Rockwell test. For even softer materials, such as rubber or TPEs, the Shore A test is recommended. Shore D Hardness is a standardized test consisting in measuring the depth of penetration of a specific indenter. The hardness value is determined by the penetration of the Durometer indenter foot into the sample. Shore Hardness measures are dimensionless. It goes between **0** and **100**. The **higher** number represents the **harder** material.

Device: Analytical balance

Manufacturer: *KERN*

This lab is equipped with an analytical balance that is a basic tool in all quantitative analyses. The device is critical for differential weighing, density determination, calibration, parts counting, animal weighing, check weighing, percent weighing, filling, gross-net-tare weighing, etc. An analytical balance provides accurate readings in educational, research, industrial, or quality control applications.

Technical specifications

Eccentric loading at 1/3 [Max]	**0.500 mg**
Linearity	**0.300 mg**
Minimum weight (USP)	**400 mg**
Readability [d]	**0.100 mg**
Repeatability	**0.200 mg**
Resolution	**3.200.000**
Stabilization time under laboratory conditions	**3 s**
Weighing capacity [Max]	**320 g**
Weighing units	**g ct mg**

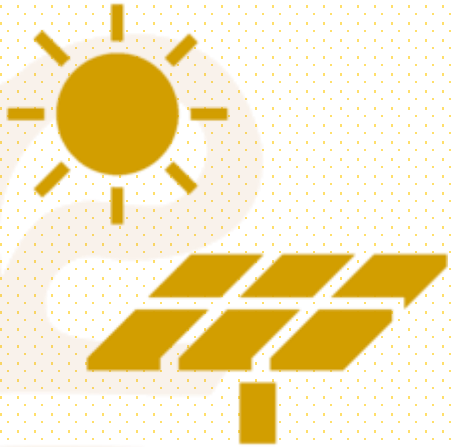
Device: Optical microscopy

Manufacturer: *LEITZ*

Technical specifications

Magnification range	**50-500**

NON-ANALYTICAL INSTRUMENTS

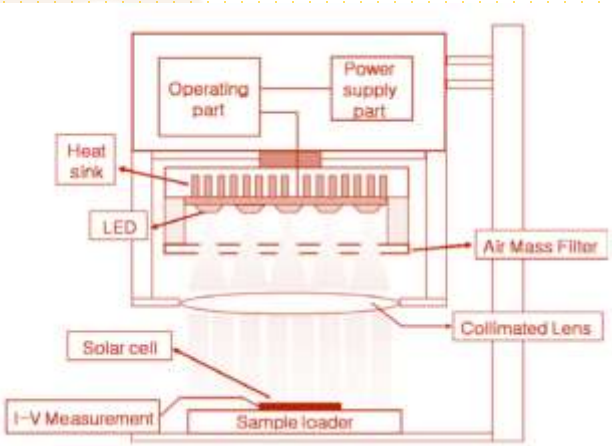


Shiraz University, Department of Materials Science and Engineering

Solar simulator

Introduction

A solar simulator (also artificial sun or sunlight simulator) is a device that provides illumination approximating natural sunlight. The purpose of the solar simulator is to provide a controllable indoor test facility under laboratory conditions. It can be used for the testing of any processes or materials that are photosensitive, including solar cells, sun screen, cosmetics, plastics, aerospace materials, skin cancer, bioluminescence, photosynthesis, water treatment, crude-oil degradation, and free radical formation. Solar simulators are used in a wide range of research areas including photobiology, photo-oxidation, photodegradation, photovoltaics, and photocatalysis. Terrestrial solar cells, for example, are measured under **AM1.5** conditions and at a temperature of 25 °C.



Schematic representation of a solar simulator used for testing of a solar cell

Device: Solar simulator

Manufacturer: *SHARIF SOLAR*

This lab is equipped with a solar simulator which uses several LEDs to produce a light spectrum with the following technical specifications.

Technical specifications

Intensity	**100 mW/cm^2 (95% resemble to the sunlight spectrum)**

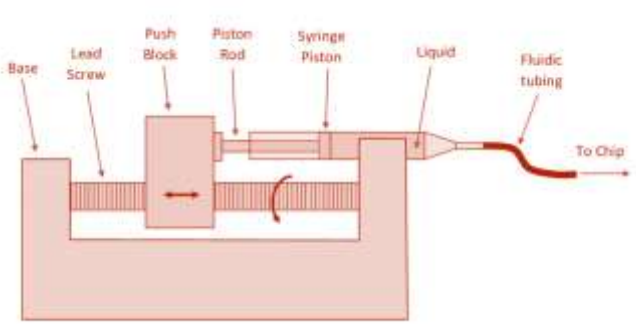
*** Equipped with several fans to cool both the specimens and LEDs**

*** Equipped with a mechanical jack to fix the distance between the specimen and light source**

Syringe pump

Introduction

A syringe driver, also known as a **syringe pump**, is a small infusion pump, used to gradually administer small amounts of fluid to a media for use in chemical and biomedical research. They help maintain a constant flow of fluids without any fluctuations with high-precision



Schematic presentation of a syringe pump

that can deliver the smallest volumetric flows down to pico-litre. Some syringe drivers can both infuse and withdraw solutions. They can be used to deliver fluids with a higher viscosity. These devices have an in-built heater that allows temperature control.

Syringe drivers can be used for electrospinning, electro-spraying, micro-dialysis, microfluidics, dispensing/dilution, tissue perfusion, fluid circulation, mass spectroscopy, calibration, drug and nutritional infusions, micro-dialysis, dispensing, chromatography and LC/HPLC, micro-reactor design and testing, enzyme kinetics studies, observation of rapid kinetics, laboratory media dispensers.

Device: Syringe pump

Manufacturer: *SANAT NAMA JAVAN*

This lab is equipped with a syringe pump with the following technical specifications.

Technical specifications

Flow rate	**0.1 to 20 (for the case of 10 ml syringe)**
Injection volume accuracy	**0.05 ml (for the case of 10 ml syringe)**
Pump pressure:	**2 bars (water at 30 °C)**

*** Capable of both infusion and withdraw (reciprocating movement)**

Device: Elevator furnace

Introduction

Elevator furnaces utilize a mechanism in which the load platform is elevated into the furnace body. As the furnace body is motionless, the insulation and interior elements are protected. These furnaces are designed for uniform thermal distribution inside the chamber, easy loading and unloading of sample with help of lifting arrangement. They are highly accessible for charging, and since the heating occurs from all four sides and the table, an outstanding uniformity in the temperature is attained. The electric bottom loading furnace is widely used for battery materials, electronic ceramics, magnetic materials, non-ferrous metals, chemical raw materials, sapphire wafer annealing and zirconia sensor heating treatment in scientific labs or universities.

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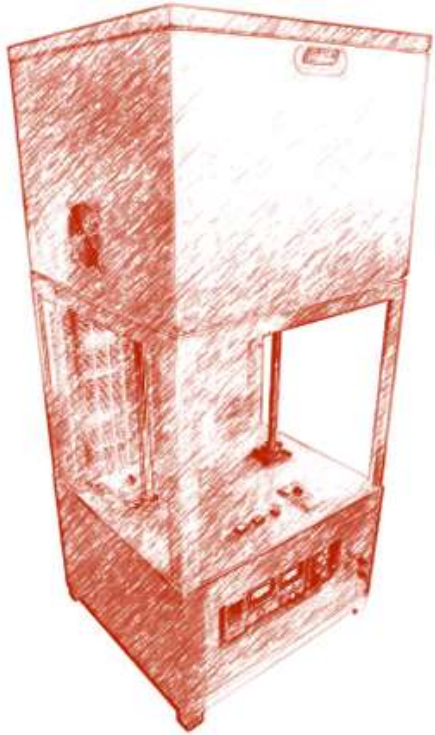


Device: Elevator furnace

Manufacturer: *AZAR FURNACE*

This lab is equipped with an elevator furnace with the following technical specifications.

Technical specifications

Max temperature	**1720 °C**
Temperature control	**1 °C**

*** Multi-segments programmable**

Device: Laboratory oven

Manufacturer: *PERSIAN TEB*

Laboratory ovens are standard equipment found in most clinical, forensic, electronics, material processing, and, research laboratories. Ovens provide uniform temperature and precise temperature control for heating, baking, evaporating, sterilizing and other industrial laboratory functions. This lab is equipped with an oven with the following specifications.

Technical specifications

Max temperature	**200 °C**
Minimum temperature	**25 °C**
Capacity	**55 L**
Temperature control	**±2 °C**
Number of trays	**2**

Device: UV ozone cleaner

Manufacturer: *SHARIF SOLAR*

In the manufacture of electronic devices, it is often necessary to clean the surface of the substrates at the atomic level and to completely remove contaminations such as organic substances from the surface. Common methods of surface cleaning using detergents often leave a layer of organic matter on the surface, which is problematic for the performance of electronic devices. The **UV-Ozone** method is a cheap and simple method to remove pollutants such as organic contaminations on the surface, fingerprints, solder oil, etc. In the UV-Ozone technique, the synergistic effect of ozone and UVC at certain distance and conditions creates an extremely oxidizing environment capable of decomposing and removing organic substances. Oxygen can be introduced into the chamber instead of air to increase the efficiency and speed of UV-ozone action. This lab is equipped with a UV ozone cleaner to serve the mentioned task.

Device: Incubator

Manufacturer: *IRAN KHODSAZ*

An **incubator** is an insulated enclosure where temperature, humidity, and other environmental conditions are regulated at optimal levels for growth, reproduction, or hatching. They are also used in microbiology, biochemistry, dairy, and other food-processing industries, as well as water and sewage treatment plans. This lab is equipped with an incubator with the following specifications.

Technical specifications

Max temperature	**100 °C**
Minimum temperature	**25 °C**
Temperature control	**±0.1 °C**

Device: Ultrasonic cleaner

Manufacturer: *iSONIC INC./CD-4820*

An **ultrasonic cleaner** is a cleaning device that uses mechanical vibrations to produce sound waves in a solution that lead to microscopic implosions of bubbles creating a vacuum-like scrubbing action that removes contaminants and dirt, a process known as cavitation. The combination of cavitation, sonic irrigation, and detergents provides a highly efficient cleaning system for delicate, sensitive, and precision instruments and devices.

Most hard, non-absorbent materials (metals, plastics, etc.) not chemically attacked by the cleaning fluid are suitable for ultrasonic cleaning including, small electronic parts, cables, rods, wires and detailed items, as well as objects made of glass, plastic, aluminum or ceramic. This lab is equipped with an ultrasonic cleaner with the mentioned specifications.

Technical specifications

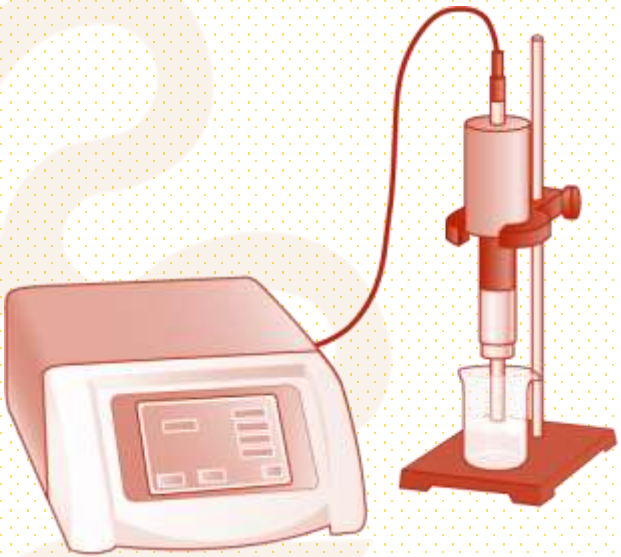
Frequency	**42 kHz**
Tank capacity	**2100 ml**

* **Equipped with heater to provide maximum temperature of 65 °C**
* **Built-in timing cycles: 90. 180, 280, 380 or 480 seconds**

Device: Ultrasonic homogenizer

Introduction

An **ultrasonic homogenizer** (or "sonicator") involves inserting a probe (or "horn") into a sample. The probe vibrates rapidly, thereby transferring its ultrasonic energy to the sample. Instead of energy being spread diffusely, the particles directly surrounding the probe get blasted with massive amounts of energy. Bubbles form and collapse in the surrounding solution, creating shear and shock waves. The highly localized intensity of the probe means the sonication process is more efficient and effective than in a bath. This makes ultrasonic homogenization ideal for particle size reduction and cell disruption. Small particle sizes can be achieved with short processing times. Applications include breaking apart suspended cells, emulsification, dispersion of nanoparticles, homogenize samples, lyse cells, reduce particle size, extract biological material, refine chemical processes liquid (or mostly liquid) samples.



Schematic presentation of the ultrasonic homogenizer

Device: Ultrasonic homogenizer

Manufacturer: *HENAN CHUANGHE LABORATORY*

Technical specifications

Output Power	**300 w – 20 kHz**
Processing capacity	**20 – 500 ml**
Sensor temperature	**0 – 300 °C**
Adjustable time	**1 s – 99 h**

Hyperthermia treatment

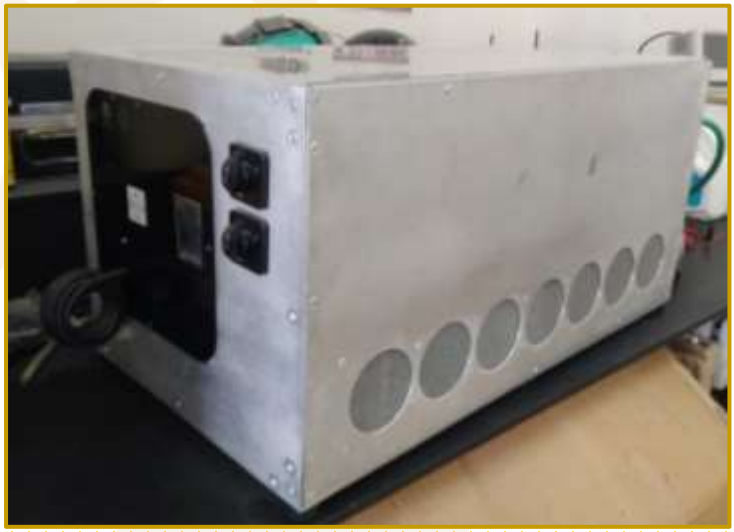
Introduction

Hyperthermia usually is taken to mean a body temperature that is higher than normal. High body temperatures are often caused by illnesses, such as fever or heat stroke. But hyperthermia can also refer to heat treatment – the carefully controlled use of heat for medical purposes. Here, we will focus on how heat is used to treat cancer. When cells in the body are exposed to higher than normal temperatures, changes take place inside the cells. These changes can make the cells more likely to be affected by other treatments such as radiation therapy or chemotherapy. Very high temperatures can kill cancer cells outright (thermal ablation), but they also can injure or kill normal cells and tissues. This is why hyperthermia must be carefully controlled.

Hyperthermia treatment

Device: Hyperthermia treatment device

Manufacturer: *Manufactured in-house (under supervision of prof. S. Javadpour)*



By creating an alternating magnetic field, this device can provide the necessary energy to de-orientate the magnetic spins in the nanostructured materials. When this magnetic energy is released, it can be converted into heat energy. Also, the friction caused by the rotation of magnetic nanostructures in the fluid with high viscosity and concentration, until reaching the state of physical equilibrium, can cause heat. Therefore, this device may be used to cure cancer after injection of the proper magnetic fluid carrying magnetic nanostructures directly into cancer tumors, through the resulting localized hyperthermia.

Device: Heater stirrer

Manufacturer: *MTOPS /MS300HS*

A hot plate stirrer or a hot plate magnetic stirrer is a laboratory instrument that is typically used to stir and heat the solution simultaneously. This helps the person performing the experiment speed up the reaction and properly dissolve the solute in the solvent. A hot plate stirrer typically works on the basis of a rotating electromagnetic field. The internal structure of the hot plate is embedded with a number of electromagnets. A magnetic bar, also known as a stir bar, is placed in the container that contains the solution. The bar is coated with a non-reactive material; therefore, it is chemically inert in nature. The beaker or flask containing the solution and the stir bar is placed on the top of the hot plate. The hot plate stirrer provides adjustment of both temperature and speed of rotation. This lab is equipped with a Heater stirrer with the following technical specifications

Technical specifications

Maximum temperature	**380 °C**
Maximum stirring speed	**1500 rpm**
Minimum stirring speed	**100 rpm**
Capacity	**5 ℓ**