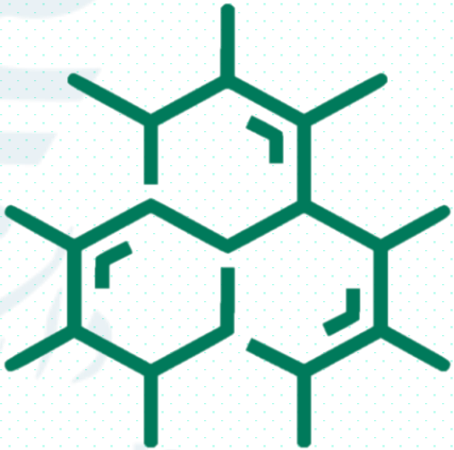
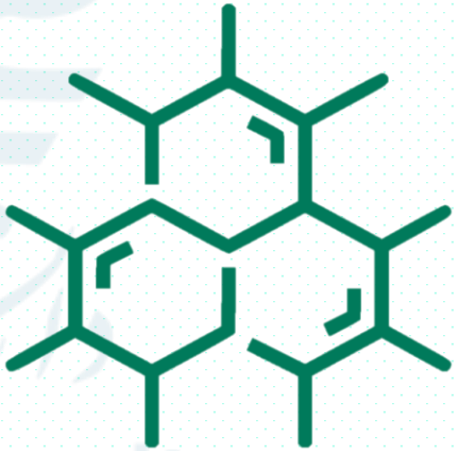
POLYMERS LABORATORY

Analytical and non-analytical instruments



ANALYTICAL INSTRUMENTS

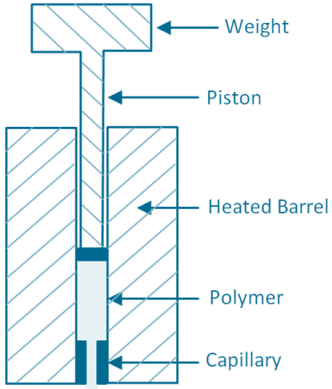


Shiraz University, Department of Materials Science and Engineering

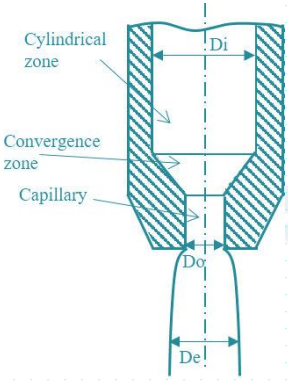
Melt flow index and Die swell

Introduction

The **melt flow index (MFI)** is a measure of the ease of flow of melted polymers. The Melt flow index is an indirect measure of the viscosity of thermoplastics. That is, higher the melt flow index corresponds to the lower viscosity. To measure MFI, a small amount of material (about 5 g) will be heated in a container above its melting or softening point and forced to flow through a capillary using a piston actuated by a specified weight. The weight of melt in grams flowing through the capillary die in 10 minutes is reported as the melt flow index.



Melt flow indexer working principal



Schematics of the die swell phenomenon

Die swell is a common phenomenon in polymer extrusion. When a viscoelastic fluid flows out of a die, the extrudate diameter is usually greater than the channel size. This is called die-swell, extrudate swell or the Barus effect. This phenomenon is due to the memory of plastic materials and usually is expressed as:

$$Die\ swell\% = \frac{D_{Extrudate} - D_{die}}{D_{die}} \times 100$$

Device: Melt flow indexer

Manufacturer: *NOANDISHAN SANAT VA TEJARAT SAMAN/MFR-02*

The polymer lab. is equipped with the melt flow indexer apparatus which can be used to determination of the die swell as well.

Technical specifications

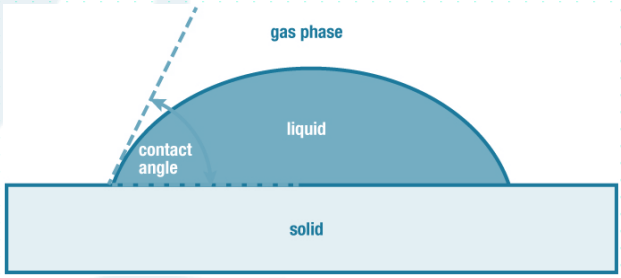
Temperature range	40-300 °C
Temperature accuracy	±0.2 °C
Standard weights (kg)	1, 1.050, 1.200, 2.160, 3.800, 5, 10, 12.5, 20, 21.6

* Three-zoned furnace

Contact angle

Introduction

Contact angle is a quantitative measure of the wetting of a solid by a liquid. The contact angle is geometrically defined as the angle formed by a liquid at the three-phase boundary where a liquid, gas, and solid intersect. The contact angle which is measured in a static condition is referred to as “static contact angle”, and the contact angle which is measured under the condition that the three-phase contact line is moving with respect to the surface is referred to as “dynamic contact angle”. The contact angle is important wherever the intensity of the phase contact between liquid and solid substances needs to be checked or assessed: coating, painting, cleaning, printing, hydrophobic or hydrophilic coating, bonding, dispersing, etc.



Definition of contact angle

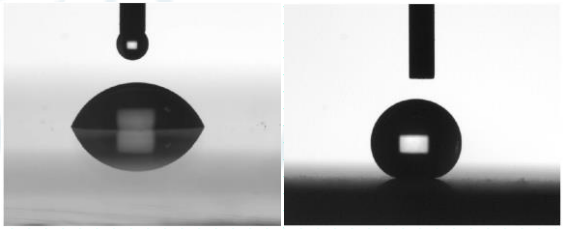
Device: Contact angle goniometer

Manufacturer: *JIKAN/CAG-10*

This lab is equipped a contact angle goniometer with the following specifications.

Technical specifications

Measuring Range | Inaccuracy	0° - 180° | ±0.1°
Camera System	Progressive CMOS sensor
	Global shutter
	Up to 150 fps optical frame rate
	1024 ×1280 Pixels
	Pixel size: 5.0 µm × 5.0 µm
	Video sequences
Optics	±1 mm working distance tolerance
Lighting System	450 nm Wavelength
	* No Heat LED
Camera Positioning	Manual X & Z direction Move
Sample Holder Positioning	Manual Z direction move
Dispenser	Automatic dispenser with nanoliter resolution (interchangeable)



* Measurement of static and dynamic contact angles (advancing, receding, roll-off, and hysteresis), as well as surface and interfacial tensions.

Device: Polymer tensile testing machine

Manufacturer: *SANAT SAYA TAJHIZ*

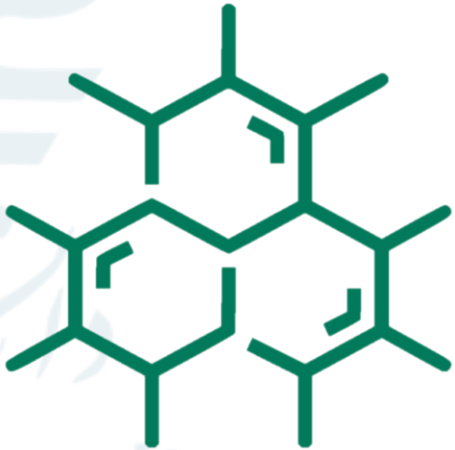
This lab is equipped with a polymer tensile test machine to investigate the mechanical properties of thin polymeric films with the following specifications.

Technical specifications

Load cells	50 kgf and 500 kgf
Crosshead speed	2-60 mm/min

* Crossheads and specimen grips designed for holding thin polymeric films
* Equipped with an extensometer
* Output data are recorded by computer

NON-ANALYTICAL INSTRUMENTS



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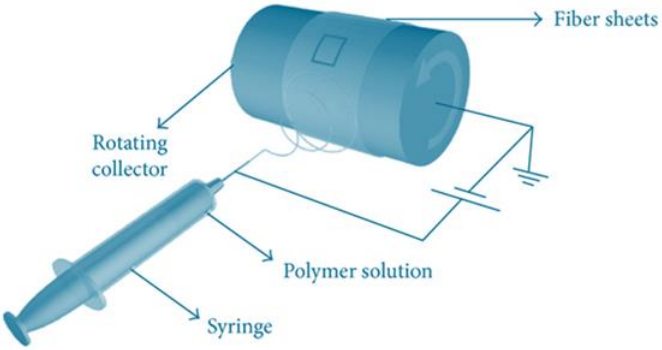
Electrospinning

Introduction

Electrospinning is a voltage-driven, fabrication process governed by a specific electrohydrodynamic phenomenon where ultrafine fibers are yielded from a polymer solution. In this method, high levels of voltage difference are established between the needle tip of a syringe containing polymer solution or melt and a collector. The characteristics of the fabricated fibers include their ultrafine (in nano-scale) size and non-woven configuration. Electrospinning finds use in several industries: life science, biomedical engineering, battery research, and the overall development, production, and commercialization of nanofiber materials for, thermal insulation, manufacturing of protective clothing, sensors, conducting devices, wound dressings, scaffolds for tissue engineering, “smart” mats, filtration membranes, catalytic supports, energy harvesting/conversion/storage components, and photonic and electronic devices, as well as biomedical scaffolds.



Principles of the electrospinning

Device: Electrospinning Machine

Manufacturer: *NANOAZMA/Three side Lab ES and Full Option Lab2 ES I-II*

Technical specifications

Voltage sources	3 independent sources providing up to 30000 V
Voltage accuracy	±0.1 kV
Collector type	dynamic
Collector geometry	cylindrical with arbitrary diameter
Collector rotational speed	100-3000 rpm
Infusion system	4 micro-pumps
Infusion flow rate	0-10 ml/h
Infusion flow rate accuracy	0.1 ml/h
Nozzles linear velocity	40 cm/h
Electrospinning distance	adjustable, 5-20 cm

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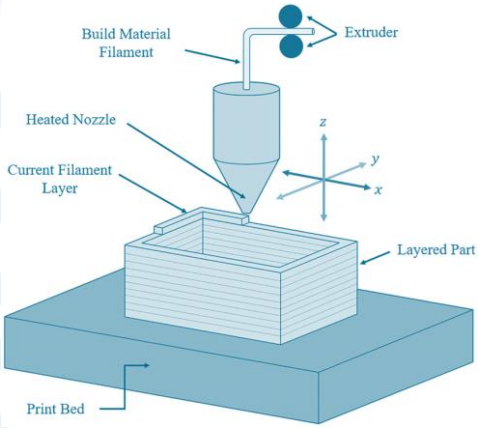
3D printing

Introduction

3D printing uses computer-aided design to create three-dimensional objects through a layering method. Sometimes referred to as additive manufacturing, 3D printing involves layering materials, like plastics, composites or bio-materials to create objects that range in shape, size, rigidity and color. They work from the ground up and pile on layer after layer until the object looks exactly like it was envisioned.



Working principle of 3D printer

Now days 3D printers find their way in such a vast areas which is even hard to just enumerate them. Nevertheless, some of the most profound areas of the applications of 3D printers include, a **Manufacturing applications**: mass customization, rapid manufacturing, rapid prototyping, agile tooling, **Medical applications**: bio-printing, medical devices, pharmaceutical formulations, **Industrial applications**: apparel, industrial art and jewelry, automotive industry, construction, home development, firearms, computers and robots, soft sensors and actuators, **Sociocultural applications**: art and jewelry, 3D selfies, communication, domestic use, environmental use, cultural heritage.

Device: 3D printer

Manufacturer: *ROBO/3D-TM*

This lab is equipped with the ROBO R1 3D printer which works based on Fused Deposition Modeling (FDM) technology to create 3D objects.

Technical specifications

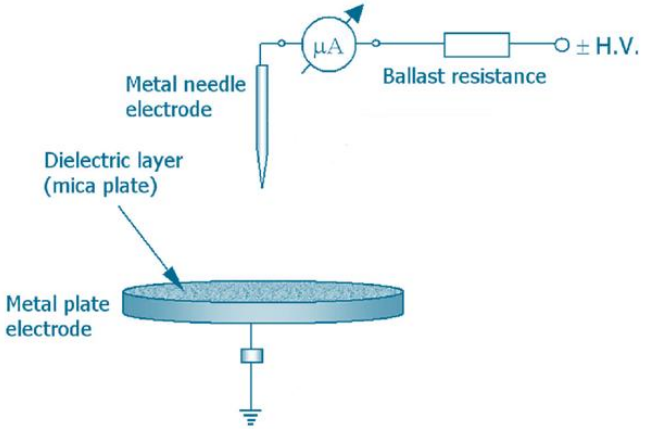
Maximum dimensions	10×9×8“
Material	Flexible range of materials, including both PLA and ABS plastics
Resolution	0.1, 0.2 (default), and 0.3 mm per layer

* Heated area of 8.4×8.4" to prevent warping and maintain even temperature distribution
* Magnetic and removable build plate

Corona poling

Introduction

The **corona effect** is a plasma-related phenomenon during which a discharge will be generated between two asymmetrical electrodes, one of which is in needle shape. The higher electrical field the pointed electrode generates plasma where subsequently small crackling arcs start to hit the second electrode; this is what is called the corona effect.



Working principle of corona poling setup

Corona discharge and corona poling have several applications such as: removal of unwanted electric charges from the surface, manufacture of ozone, nitrogen laser, ionization of a gaseous sample for subsequent analysis in a mass spectrometer or an ion mobility spectrometer, static charge neutralization, refrigeration of electronic devices by forced convection, piezoelectric polymers, plasma surface treatment for increase the wettability, pole films of electro-optic materials to enhance their electro-optic properties, potential accumulation and polarization switching in polymer films and ceramics.

Device: Corona poling setup

Manufacturer: *MAHAD SANAT ASIA*

Polymer lab. is equipped with the corona poling setup with the following specifications.

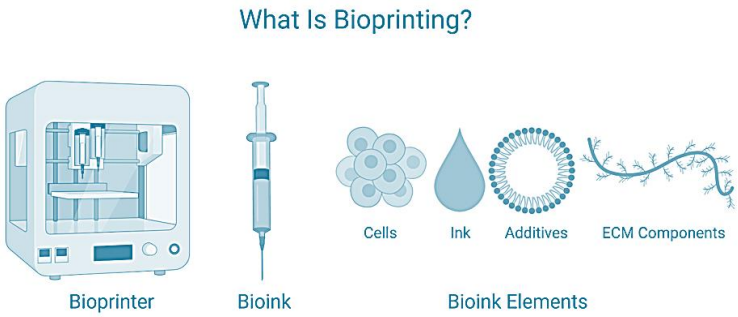
Technical specifications

* Adjustable voltage
* Adjustable distance between needle electrode and plate
* Heating the plate electrode up to 80 °C

Bioprinting

Introduction

Tissue engineering and regenerative medicine are relying more on **3D bioprinting** to conduct non-invasive research. Generating live tissues offers a unique opportunity for studying effects of medications and treatments in an isolated environment.



Schematic of the working principle of bioprinters

Soon 3D bioprinting will assist us in replacing damaged organs with lab-grown printed ones. Bioprinters use a combination of biomaterials, in which living cells are embedded, to create 3-dimentional structures of cell-embedded gels/liquids and scaffolds. These structures are pre-programmed for the printer and are printed layer by layer.

Device: Bioprinter

Manufacturer: *3DPL/N2 Plus*

Polymer lab. is equipped with the bioprinter with the following specifications.

Technical specifications

Build volume	125*85*55 mm
Resolution	5 microns
* Clean chamber equipped with UVC lamp and HEPA filter	
Usable nozzles	Brass nozzle for thermoplastic printing, conical and stainless-steel nozzle for hydrogel printing
Printing mechanism	Pneumatic
Pressure range	0.2 to 700 kPa
Printable material	PCL, PCL Composite, PU, GELMA, Silk, Hydrogel Solutions with cells, Alginate, etc.
Number of extruders	2
Head temperature	RT to 175 °C
Bed temperature	RT to 65 °C
Photocuring	UV (365nm), Blue Light (405nm)
Print Head	Heating, Cooling, Photocuring

Device: Universal centrifuge

Manufacturer: *POLE IDEAL TAJHIZ CO./PIT-320 classic*

Technical specifications

Maximum rotational velocity	9000 rpm
Maximum relative centrifugal force	21382
Maximum density	1.2 kg/dm3

* Capable of using the device based on rpm and RCF
* Standard 15 and 50 ml falcon tubes
* Capable of changing the centrifuge parameters (rotational speed, time, etc.) during operation
* Adjustable centrifuging time up to 99′:59″ and nonstop mode (unlimited time)

Device: Digital Incubator

Manufacturer: *PECO/PI-445*

Technical specifications

Capacity	45 L
Maximum temperature	45 °C
Temperature accuracy	±0.02 °C

Device: Hydraulic press

Manufacturer: *FOROUZAN SANAT KISH/SANAT SAYA TAJHIZ*

Technical specifications

Maximum force	**5 ton**

Device: Polymer rolling device

Manufacturer: *SANAT SAYA TAJHIZ*

Technical specifications

Rolls radius	**1”**
Gap increment	**0.1 mm**

* Capable of measurement and displaying rolling force

* Rolling in forward and reverse direction