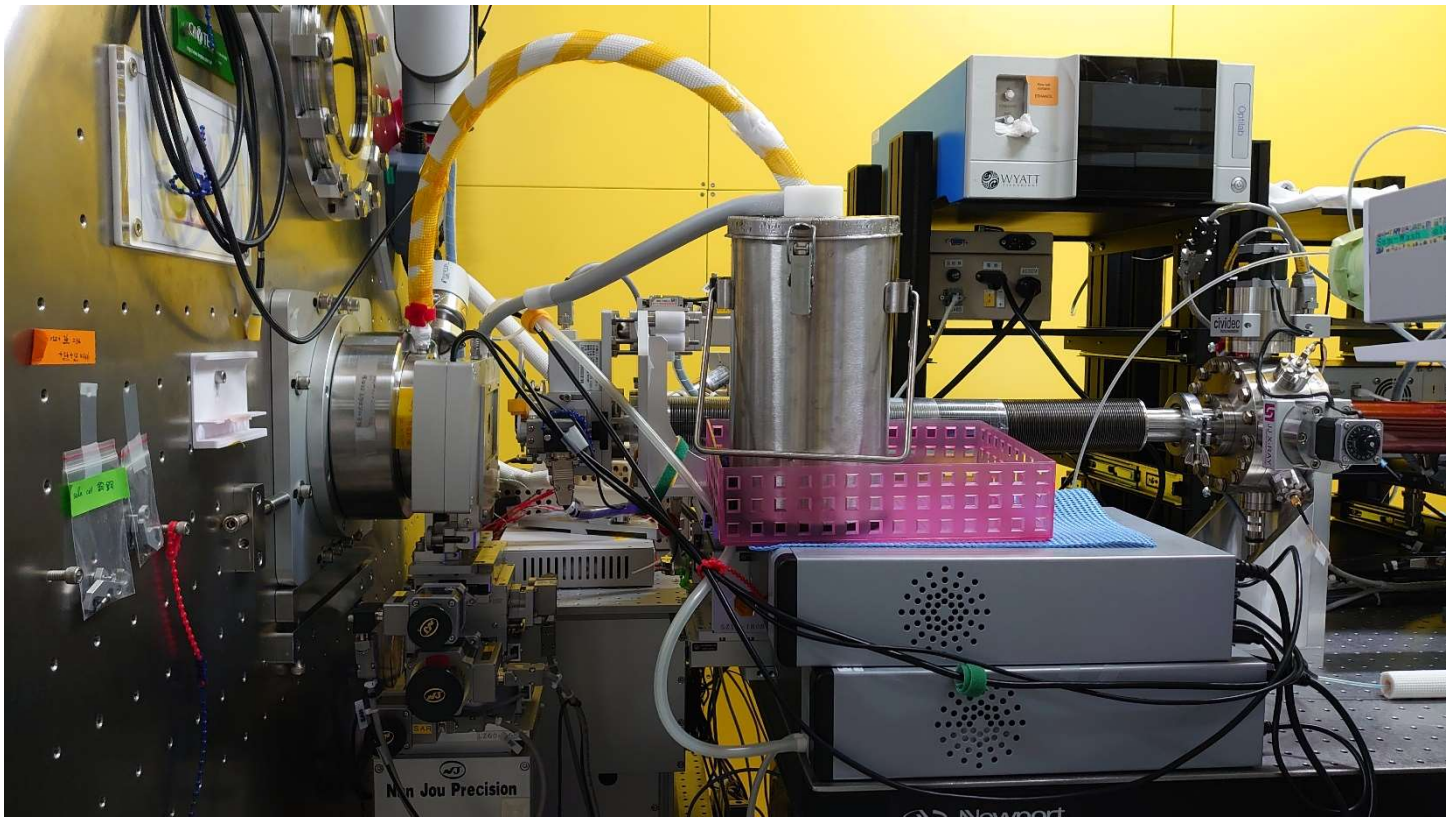
TPS 13A
Modular Force and
Temperature Control Stage Guide



TPS 13A Linkam tensor testor353 規格

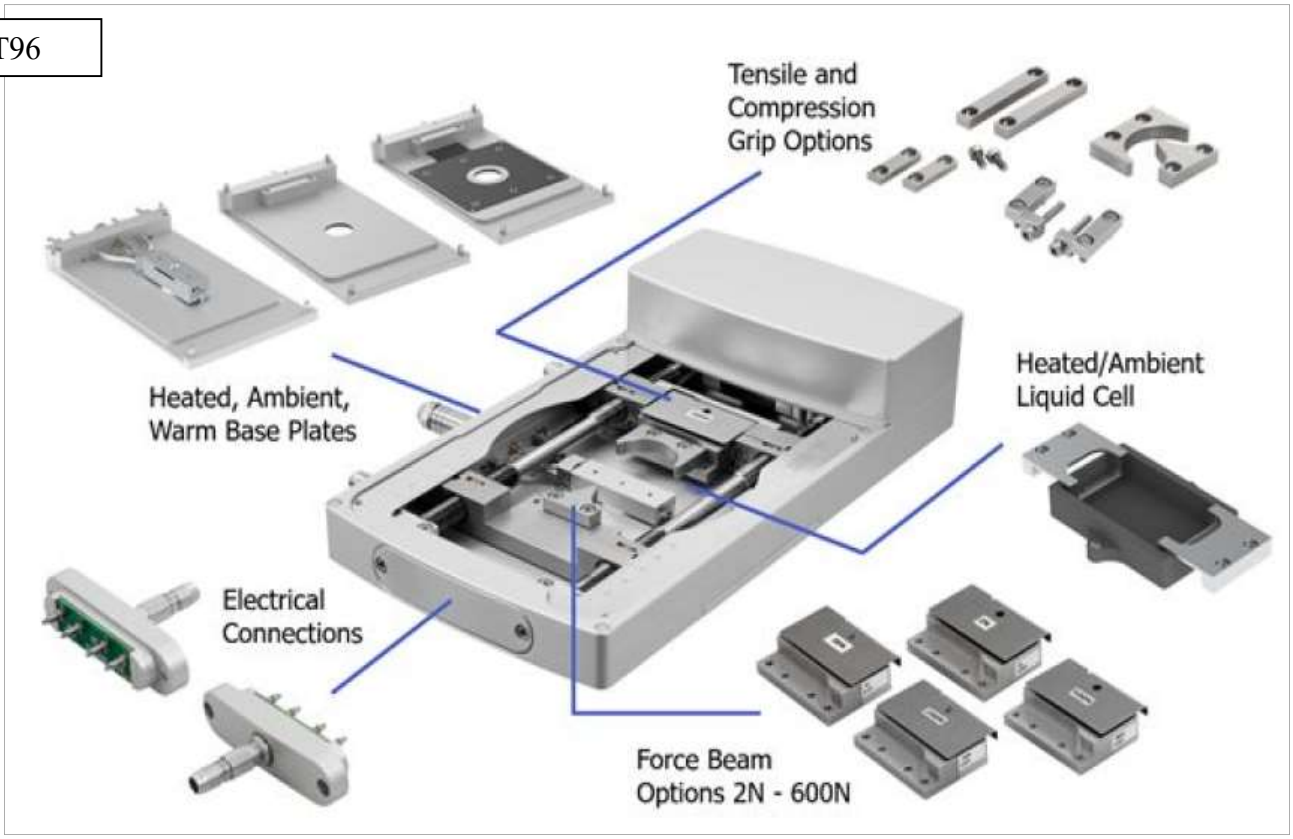
TPS13A樣品應力應變儀
TPS13A樣品應力應變儀 主要功能系統包含
•應力應變力量測系統
•溫控系統
•濕度控制系統

規格

X-ray in-out window sizes 進出	入射窗孔徑>2 mm 出射窗孔徑>20 mm
溫控範圍 Temp range	-190 °C to 240 °C 拉力下 (under stretching) -190 °C to 340 °C 無拉力下 (no stretching)
加溫速率 heating rate	0.01°C/min to 50°C/min
拉力範圍 (pulling force)	0 N to 200 N
樣品最大拉伸長度 (extension range)	60 mm
	可接電路於拉力下加電壓
	可氣密, 也有抽換氣體之功能
濕度控制(humidity range control)	相對溼度 10 - 80%
拉力速度 (pulling speed)	> 900 µm/s
拉力基板 (with applied voltage to sample)	< 0.002N (20N version) or ＜ 0.02N (200N version)
拉力室(air tight/ gas environment control)	整合拉力,適度及溫度控制的介面軟體

Linkam拉伸機 (Modular Force Stage) 操作手冊

T96



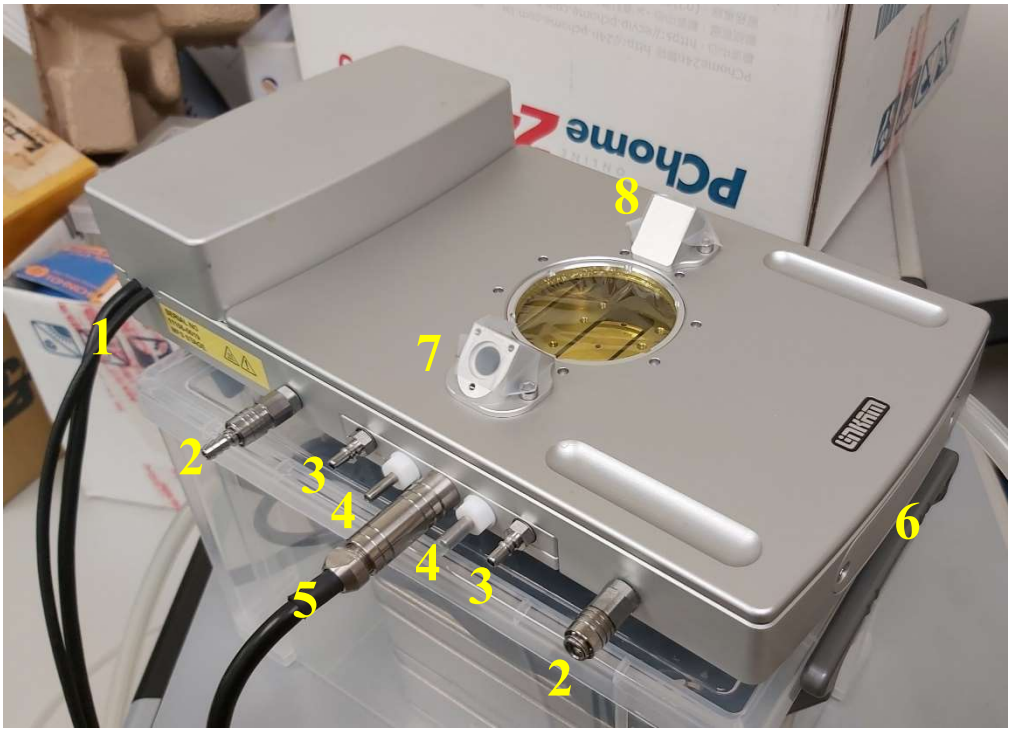
基本的拉伸機系統包含拉伸機基座、Force Beam與T96溫控系統，連接著軟體(LINK)操作與液氮冷卻系統。

規格

Maximum temperature:	350°C	
Minimum temperature:	Room temperature or -195°C with optional liquid nitrogen pump (LNP)	
Maximum heating rate:	60°C/min	
Maximum cooling rate:	60°C/min with optional LNP	
Maximum tensile and compressive:	20N Force resolution:	0.0001N
	200N Force resolution:	0.001N
Maximum Speed:	5000µm/s (dependent on force beam installed)	
Minimum speed:	0.1µm/s	

目前現有20N與200N的Force Beam各代表0.0001N與0.001N的解析度，200N比20N更能拉伸鋼性更強的材料，但是量測解析度就會下降至0.001N。不過這樣的解析度都是相當高了

管路連接



拉伸機系統的外接管線配置如上圖所示

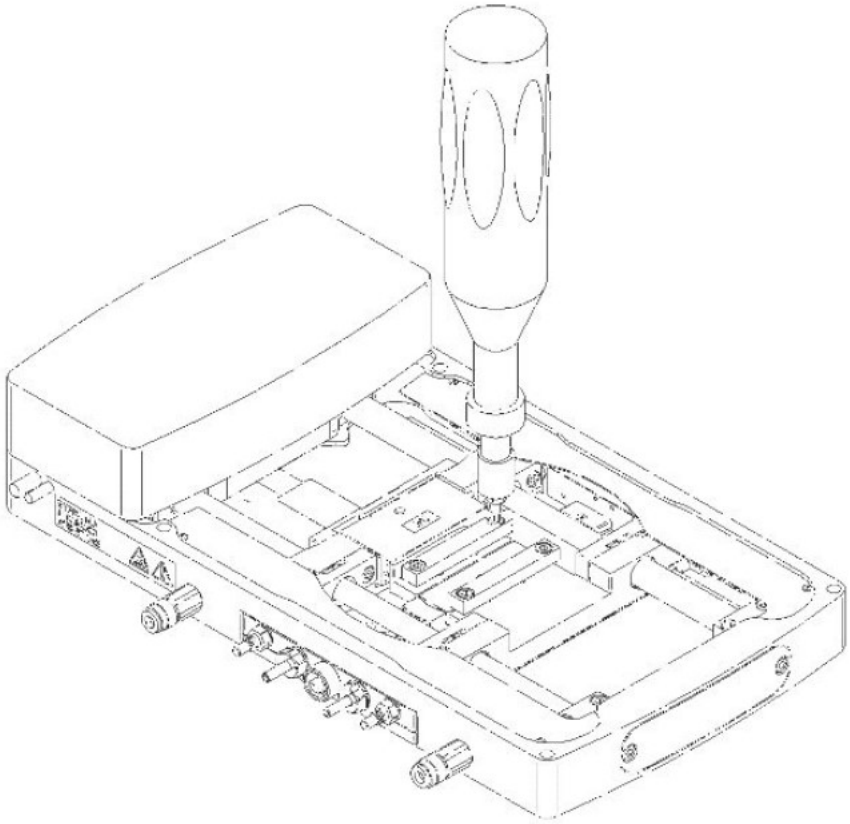
- 1 連接T96儀器
- 2 氣體連接孔
- 3 連接水冷儀器
- 4 連接液氮系統
- 5 連接T96儀器
- 6 額外擴充
- 7 humidity sensor connector port
- 8 humidity air inlet 濕度控制接線

Optional LNP connected via the Instrument bus cable

T96與拉伸機連接如上圖所示，之後使用USB線連接電腦與T96機器後端，開啟軟體LINK

拉伸機操作流程

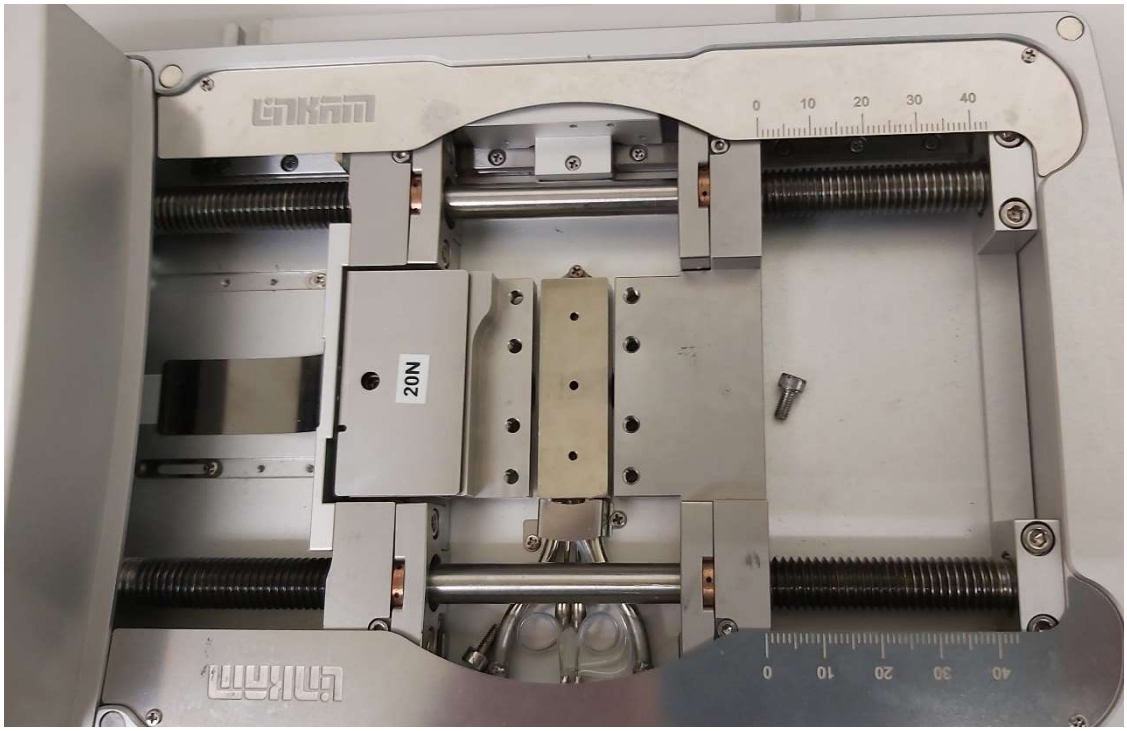
- 先移開grip與上蓋
- 應力與拉伸距離歸零
- 裝填樣品並裝上grip
- 拉伸樣品
- 紀錄數據

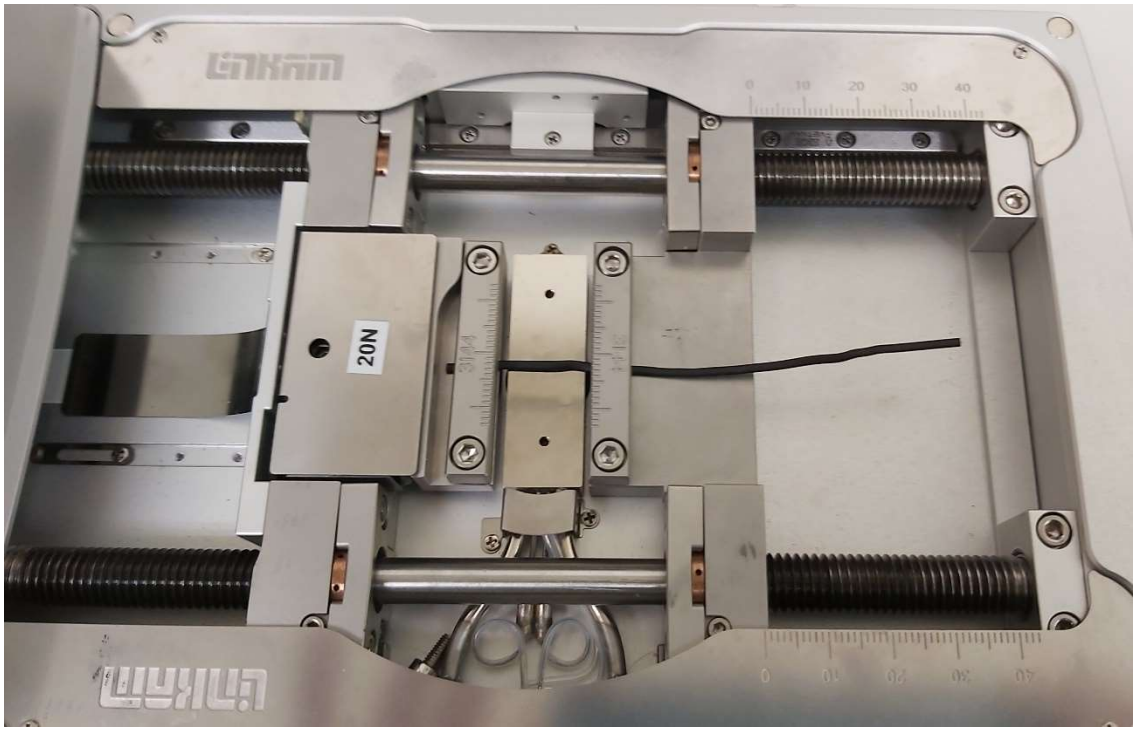


1. 先移開grip與上蓋

將grip轉開可以用一般六角板手，但鎖回去建議要用扭力板手，需平均兩側應力。

3. 装填様品並装上grip

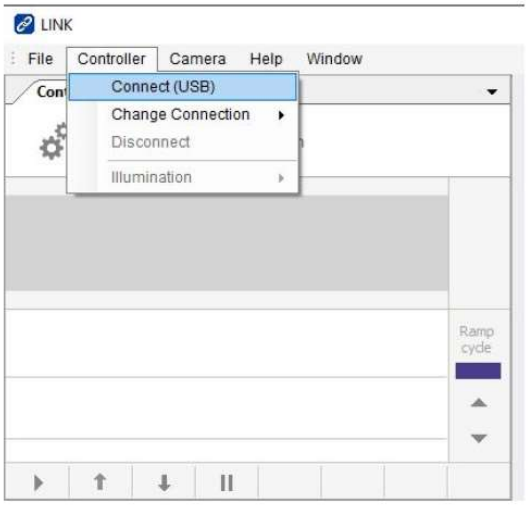




Connecting the stage

Once all the connections have been made please switch on the controllers – if using the optional LNP9X this should be switched on first followed by the T9X controller otherwise the LNP9X will not be detected.

Start LINK software and choose Connect to connect to the T9X controller

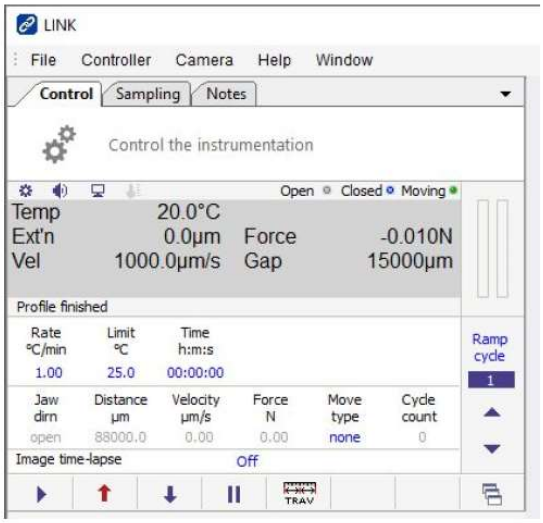


2. 應力與拉伸距離歸零

用USB線將機器與電腦連接好，打開LINK軟體，選Connect(USB)連接。

Control Tab

Once a connection has been made successfully, you should see the Control Tab as shown below displaying information about the status of the MFS, including Temperature, Force, Velocity, Gap, etc.



The Control Tab is where you can set up experimental conditions and program a ramp or series of ramps, known as a profile. Generally, if it's blue, you can click to toggle or input a value to change it.

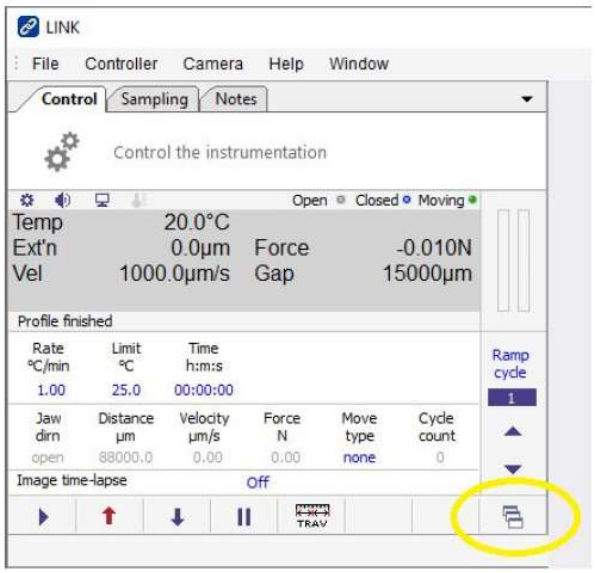
Please see the LINK user guide for full details on these functions.

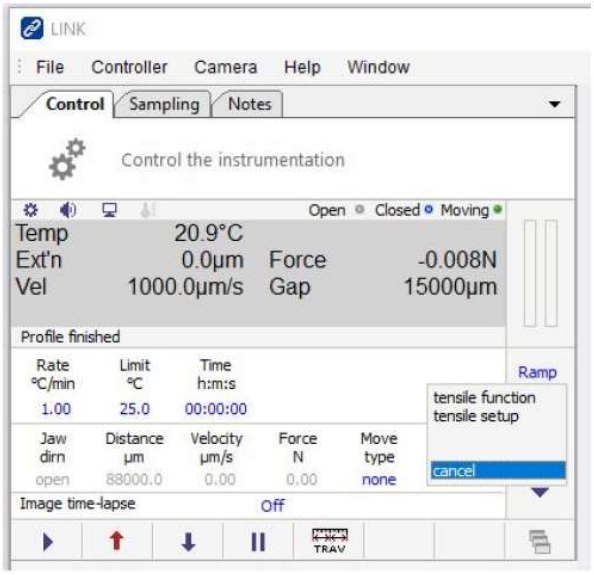
面板上會顯示一般的各項參數

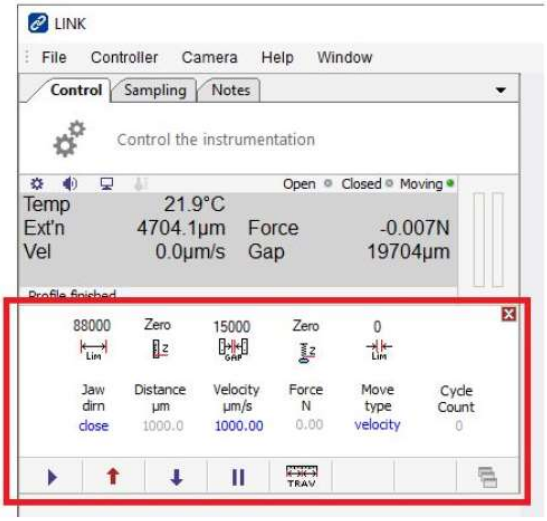
Tensile Function

This area allows unrecorded movement of the jaws and contains various setup parameters.

Click the icon circled below to gain access to further instrument related menus and choose tensile function.





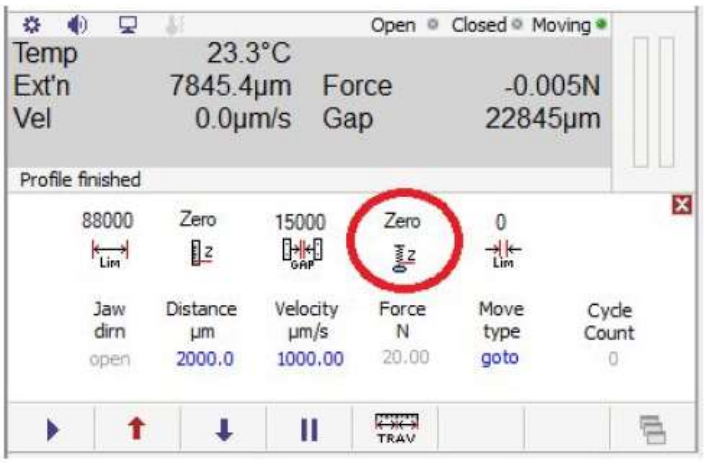


Here you can zero the force and distance values, if required. A number of other parameters can also be set in this panel.

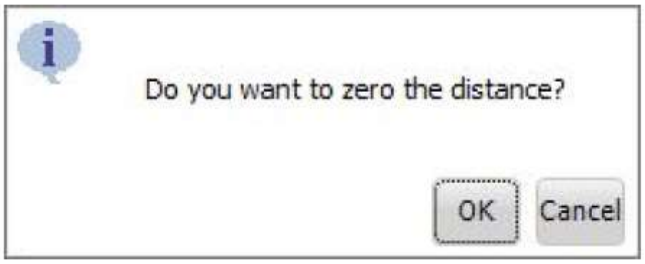
click the start button to action it. The action will start and either stop by itself at the end of the command, or you can stop early by clicking the stop button.

在軟體介面右下角選擇tensile function，拉伸機的各項功能介面就會出現，
這時就可以將應力與距離歸零。(下頁介紹)

Zero the force



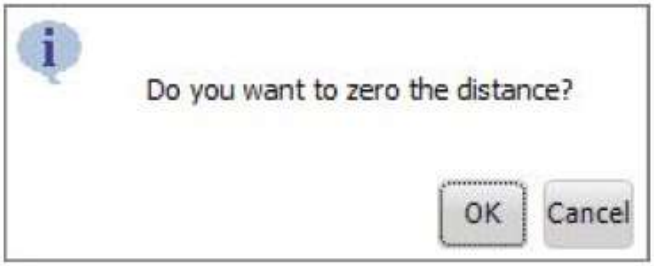
Click to zero the force. A confirmation window will pop up – click 'OK' if you are happy to proceed



點選圖示，將應力歸零。

Zero the distance

Click to zero the distance. A confirmation window will pop up – click 'OK' if you are happy to proceed.



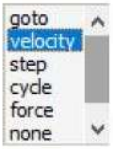
點選圖示，將距離歸零。

4. 拉伸樣品

Move type

There are several options are available for the type of move to program. The main display and tensile function use the same options. If the text is shown in blue it is possible to change it.

Click 'Move type' to display the list of options available.



在Move type圖示下可以選擇拉伸的模式

Goto

Goto allows you to enter an absolute gap and go to it. Click the distance value to set your desired gap to go to.

“Goto”模式下，點選並鍵入欲到達的距離

假如輸入的距離超過規格範圍，會跳出警告。

Velocity

Click to enter the desired velocity

Use the keyboard or mouse to enter your desired velocity. If you try to enter anything outside of the range shown, a warning will pop up.

在”Velocity”模式下，可以選擇想要的移動速度(μm/s)，但輸入的速度超過規格範圍會跳出警告。

Cycle

Cycle move type is a repeating step motion.

Click to toggle the jaw direction for the initial move, enter the step size using the Distance value and enter the Velocity.

Click the cycle count to enter how many cycles to perform. (0=continuous).

循環模式，Cycle count輸入0時，為無限次重複

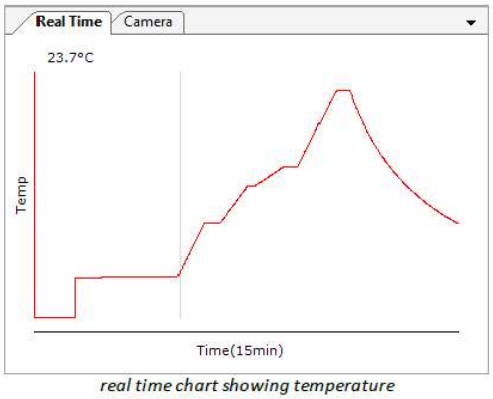
5. 紀錄數據

Data Recording

This section describes the data recording functionality of the LINK software.

Real time chart

While a stage is connected, LINK will display a real time chart for each of the values being measured. This is on the left hand side of the LINK screen, under the main control screen.



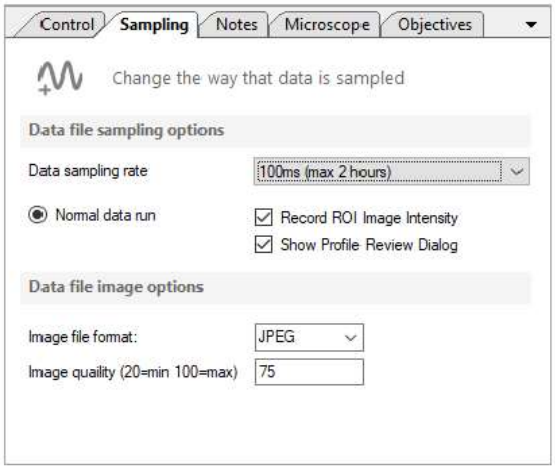
real time chart showing temperature

- If a stage with multiple outputs (such as Heat, Stress and Strain on a TST350) is in use, there will be a separate real time chart for each output.
- If the 'Record ROI Image Intensity' check box in the Data Sampling Options tab is checked, there will be a separate real time chart showing the image intensity value against time.
- To view the specific value at any point on the graph, click and drag the cursor bar to the point of interest, and the specific value will be displayed above the chart.
- The chart will show the last 15 minutes of real time.
- If a unit is changed (such as changing from mBar to Pa on a vacuum stage) the chart will reset.
- Right clicking on the chart will bring up an option to clear it.

"LINK" 軟體介面可以顯示Real time chart，可以顯示時間對各項數據輸出(包含溫度、應力、應變…)

Data Sampling Options

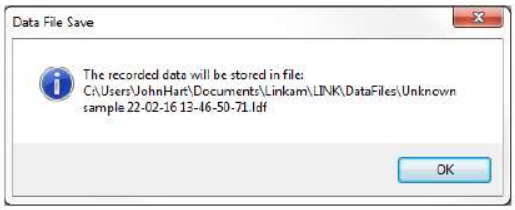
To change settings regarding the way data is recorded and saved in LINK, click on the 'Sampling' tab at the top of the main control screen.



數據的紀錄設定可以在Data Sampling Option裡調整。

Saving a data file

When a profile is completed, LINK will automatically save the resulting data to a file, and will pop up with a confirmation dialogue showing the file name and path of the saved data file. To modify the file naming options, see Sample Notes.

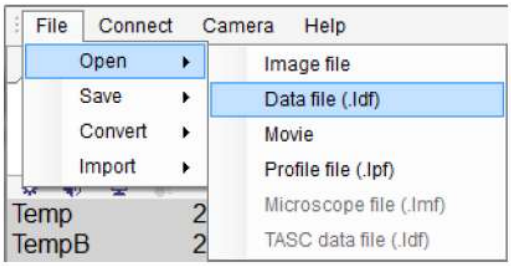


當專案量測結束時會自動存檔

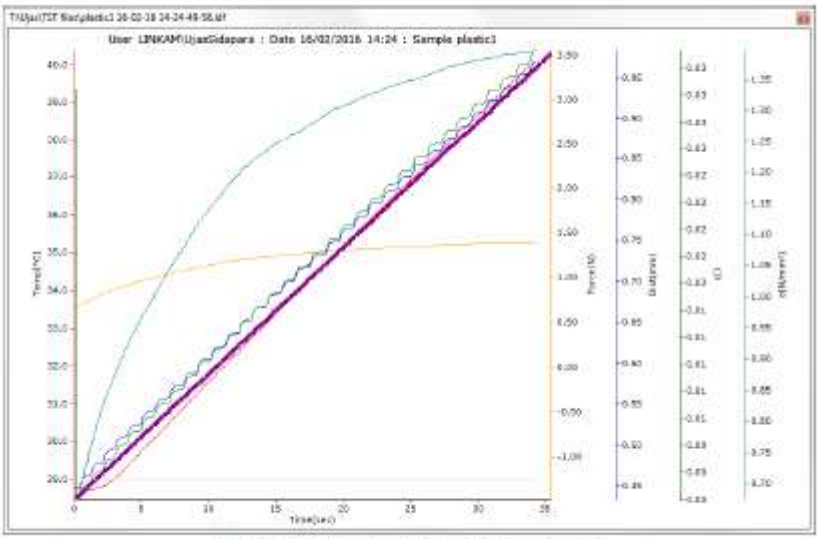
Opening and annotating a data file

Opening a data file

To open a previously saved data file, click on 'File' -> 'Open' -> 'Data file (.ldf)'



Note: Saved data file can also be opened by double clicking on them in Windows explorer or by 'dragging and dropping' the file into LINK. A data file will also be opened automatically immediately after it is first saved.

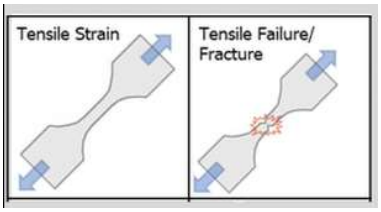


Data file from a TST350 stage

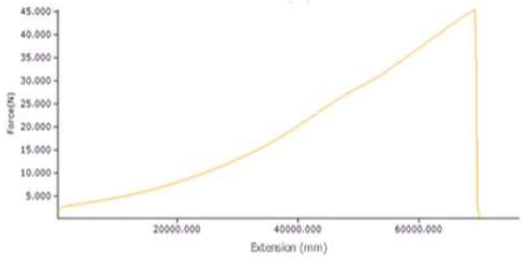
檔案可以使用”LINK”軟體開啟，畫面上會顯示數據圖。

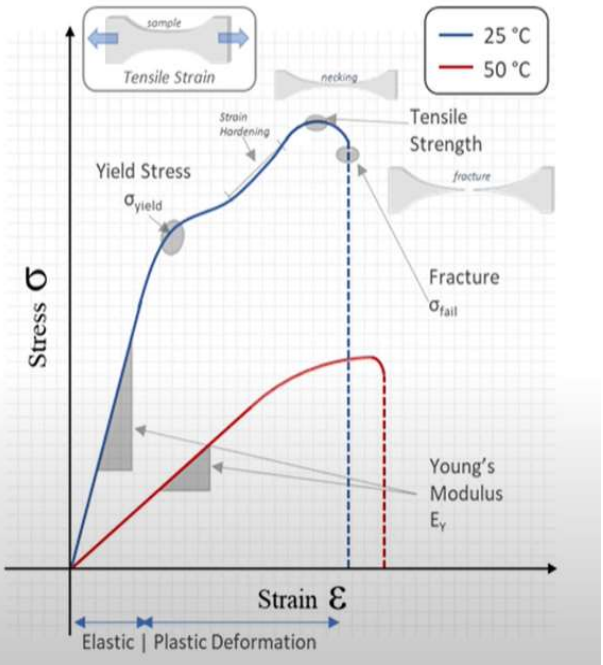
試驗範例

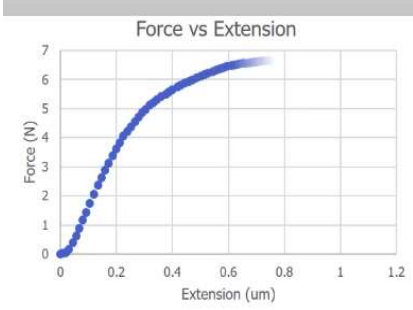
1. 拉伸至斷裂模式

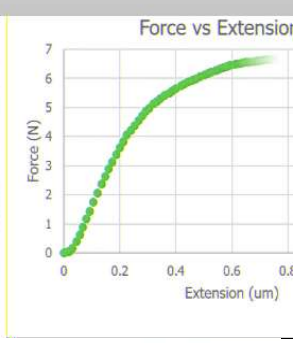


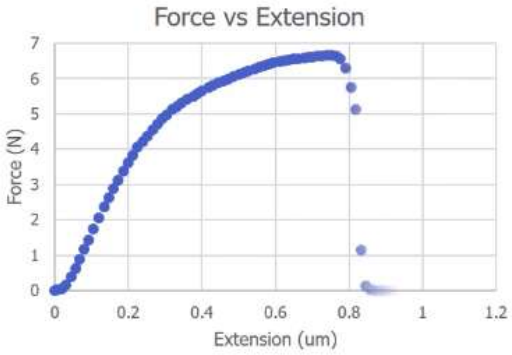
Yield Strength (降伏強度):
材料受拉力後，剛產生永久變形（或稱塑性變形）而無法彈回原位時之強度
Tensile Strength (拉伸強度):
計算試樣品斷裂前所能承受的最大應力

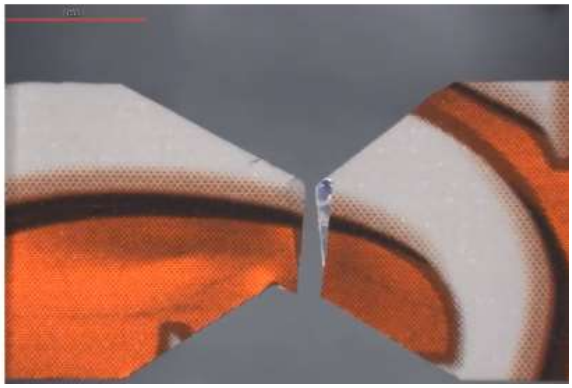




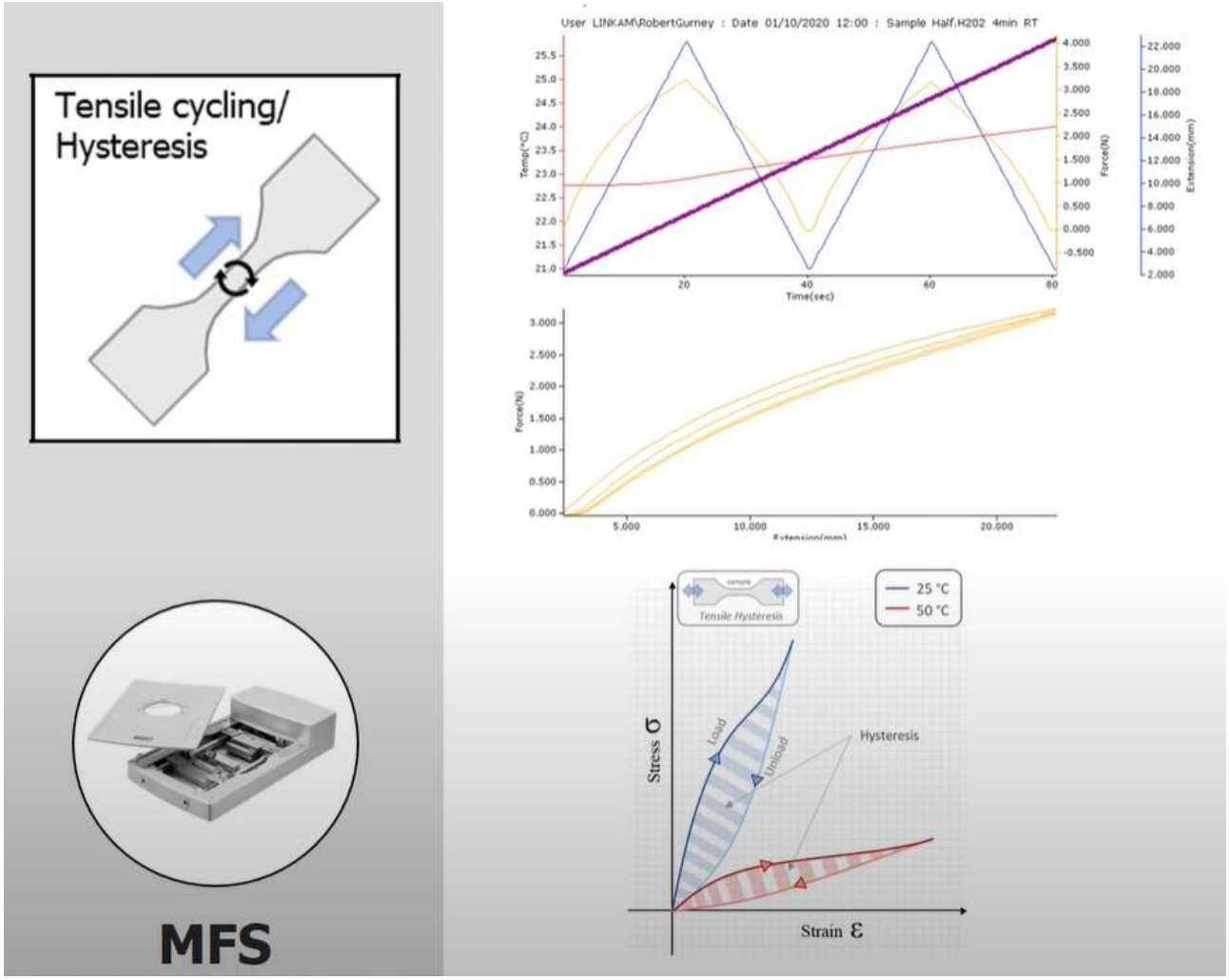








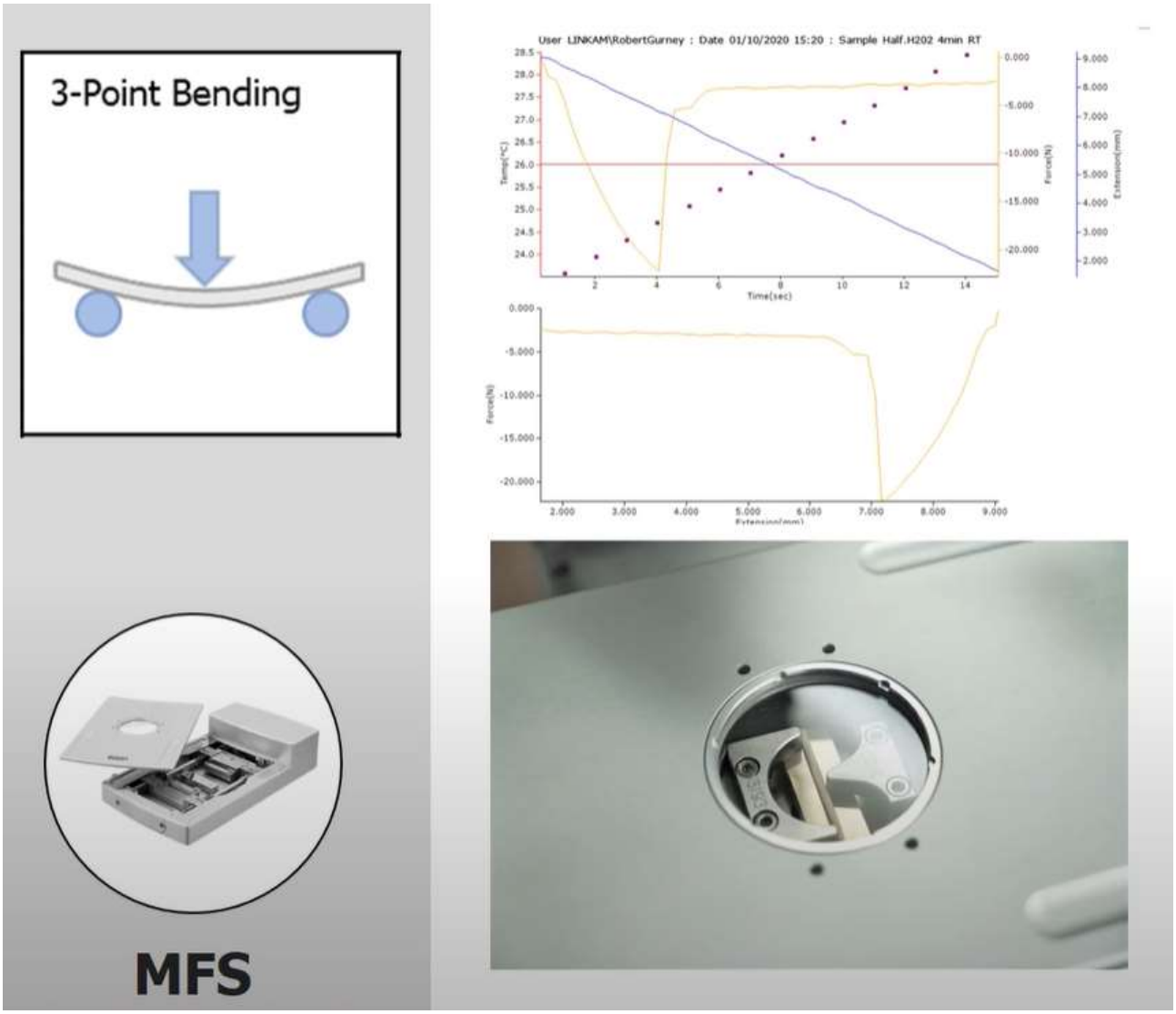
2. 拉伸循環



拉伸至某固定距離再回覆至原始距離，往覆移動

遲滯現象:理論上在彈性區域不斷重複拉伸，應該遵循相同的曲線，但實際上並不經常發生，拉伸過程可能在某處損失一些能量或是超過降伏點，造成遲滯現象

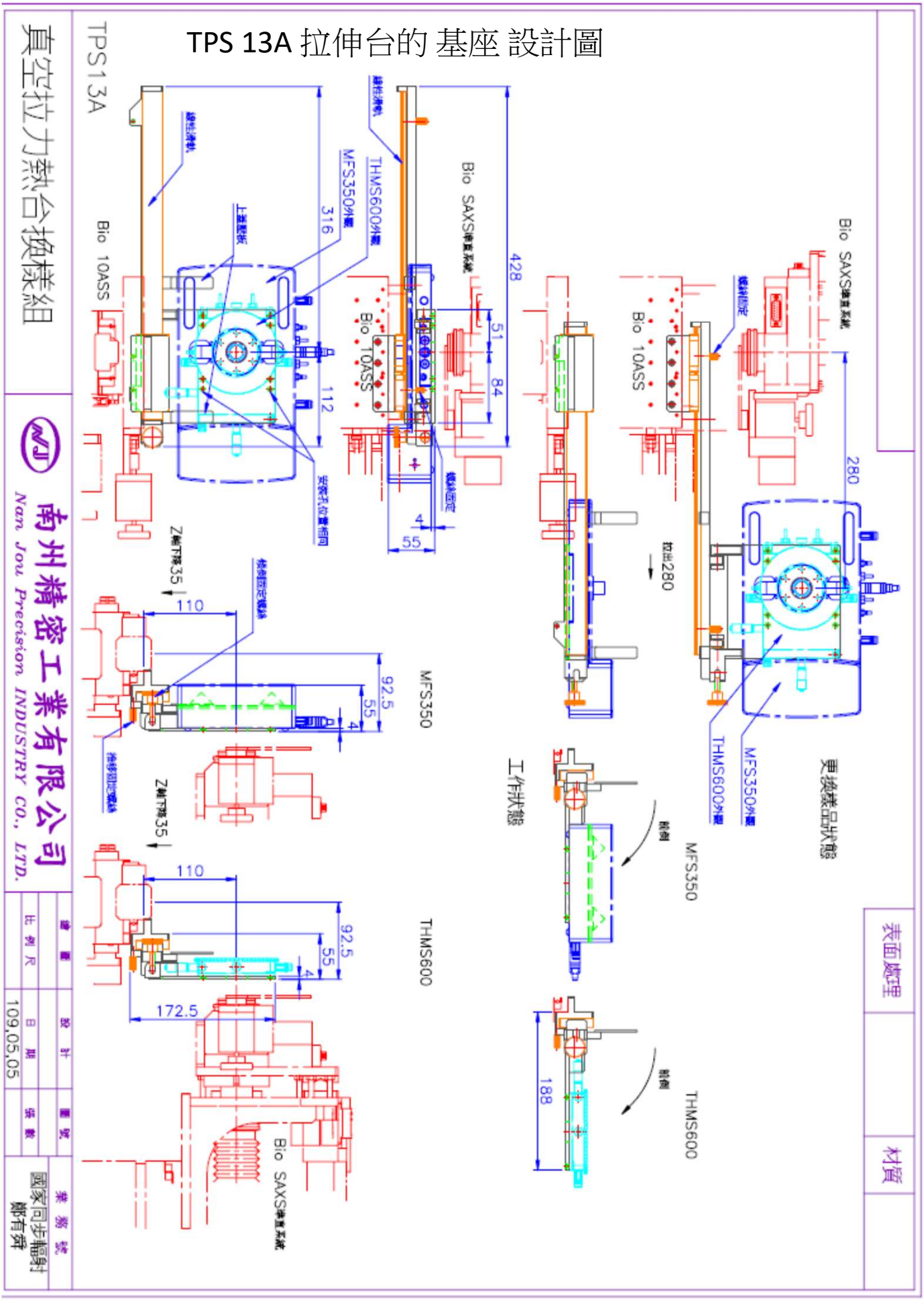
3. 彎曲（剪應力）



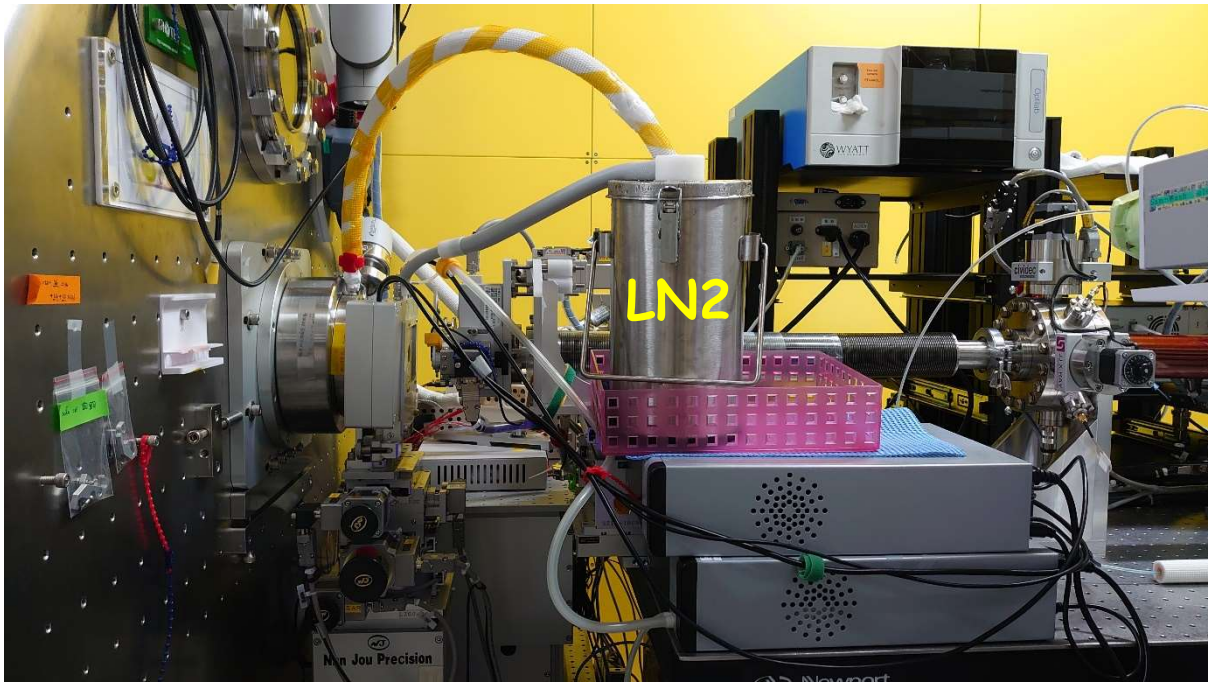
查看黃色線，會看到樣品抵抗所施加的力，並且三個點彎曲，
最終它斷裂並且力返回為0

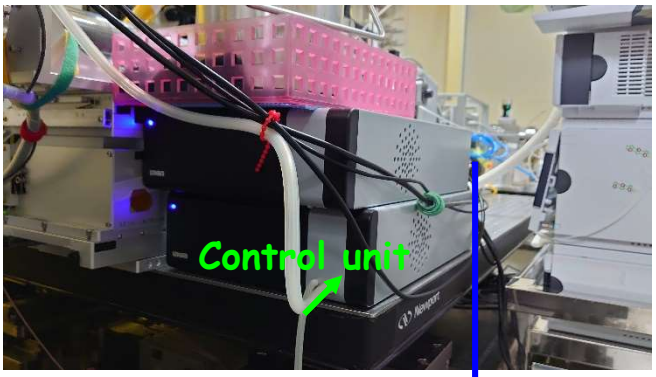
參考影片https://www.youtube.com/watch?v=0RIpSa8BwWc

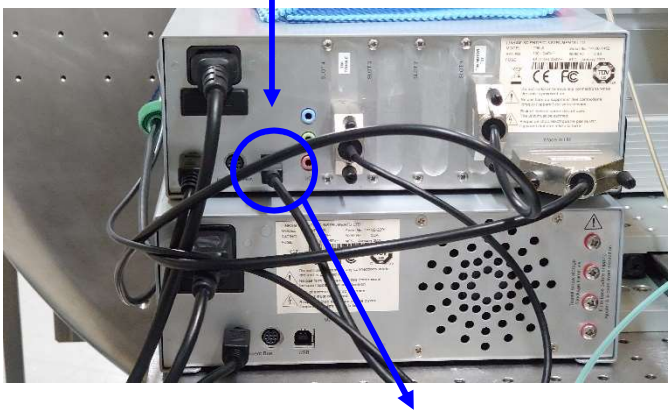
TPS 13A 拉伸台的 基座 設計圖



TPS13A Modular Force and Temperature Control Stage setup

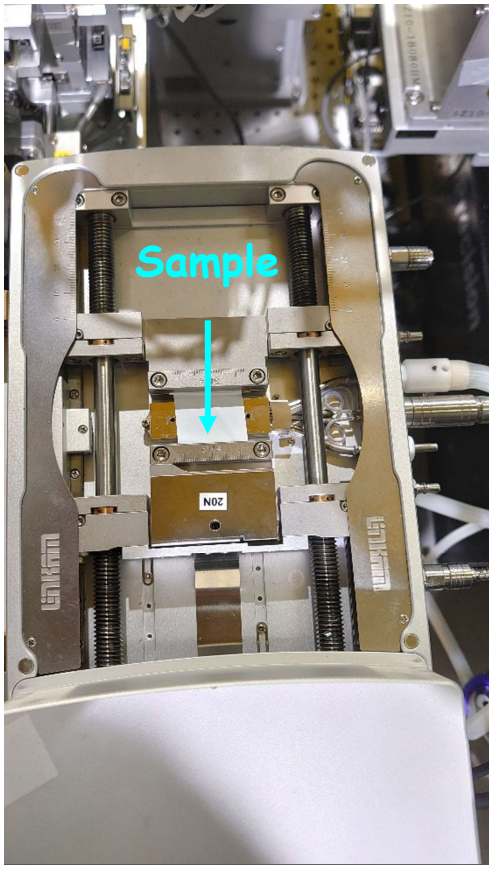


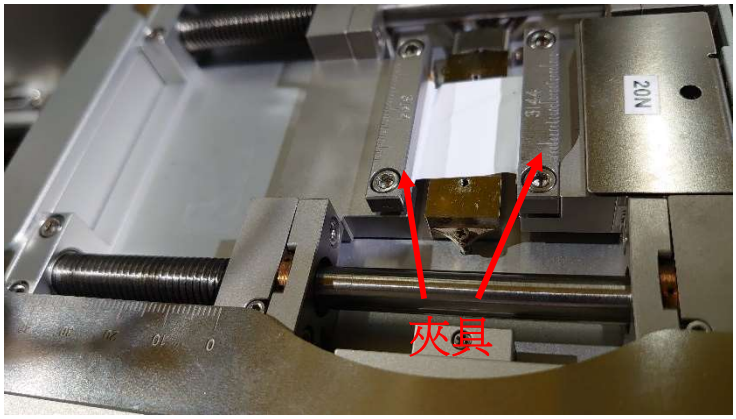


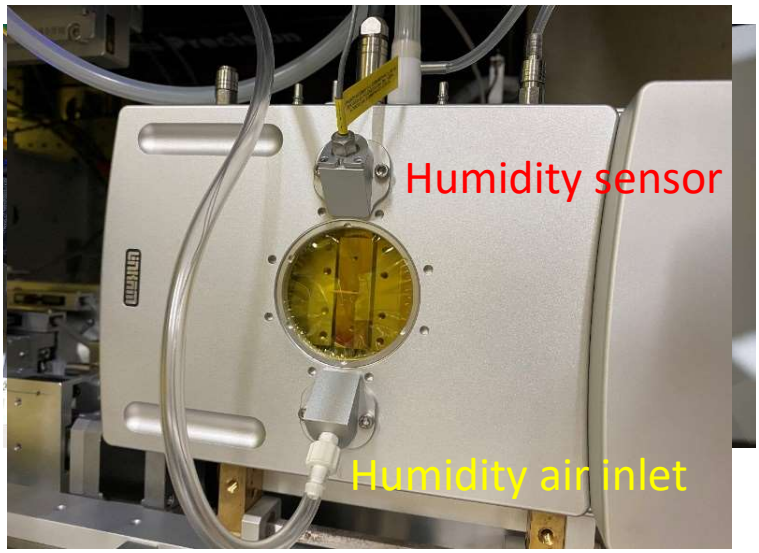


to notebook

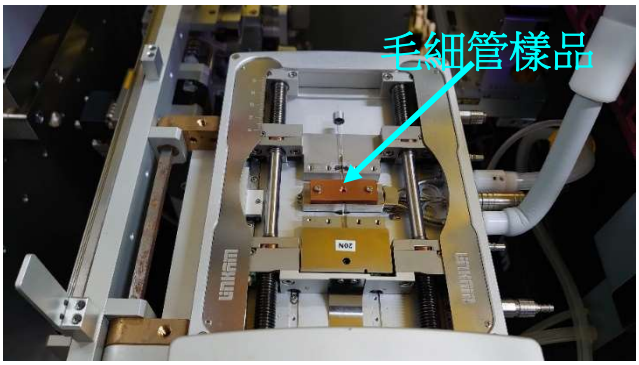
Modular Force mode temperature + humidity controls

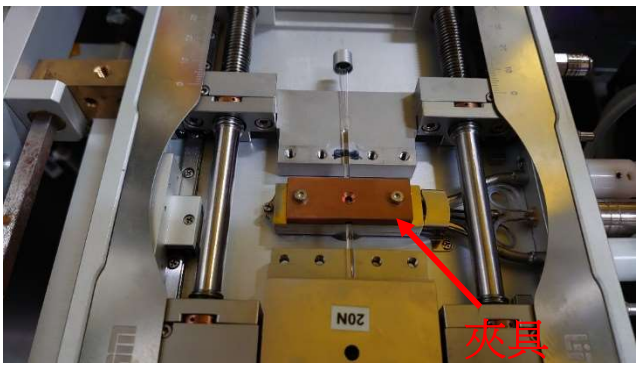


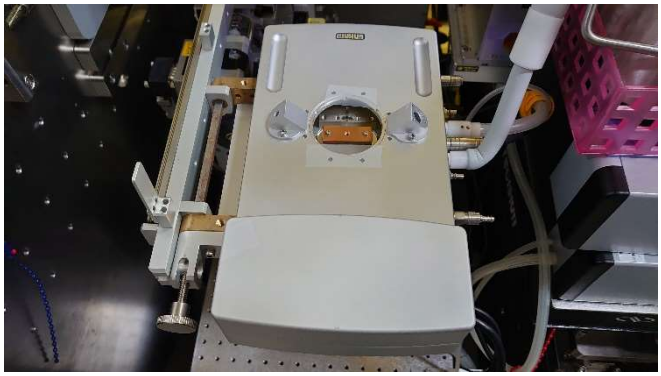




Capillary mode

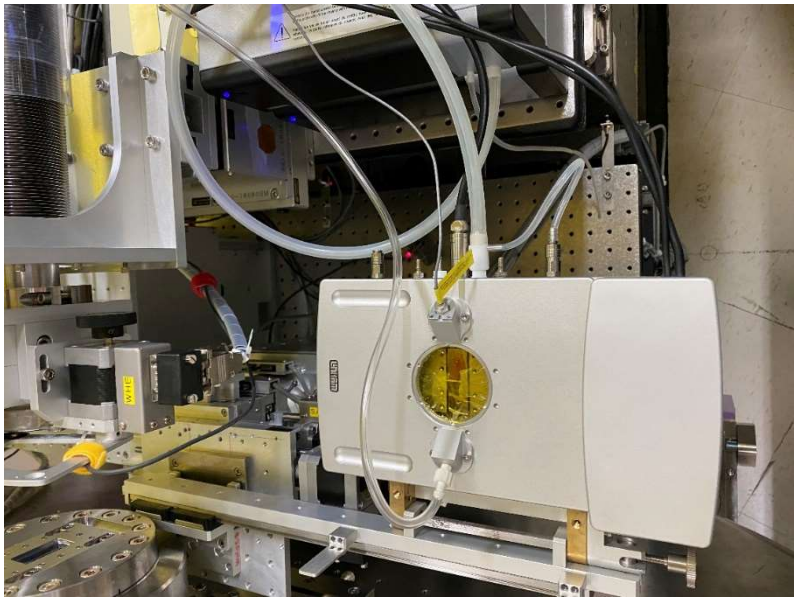




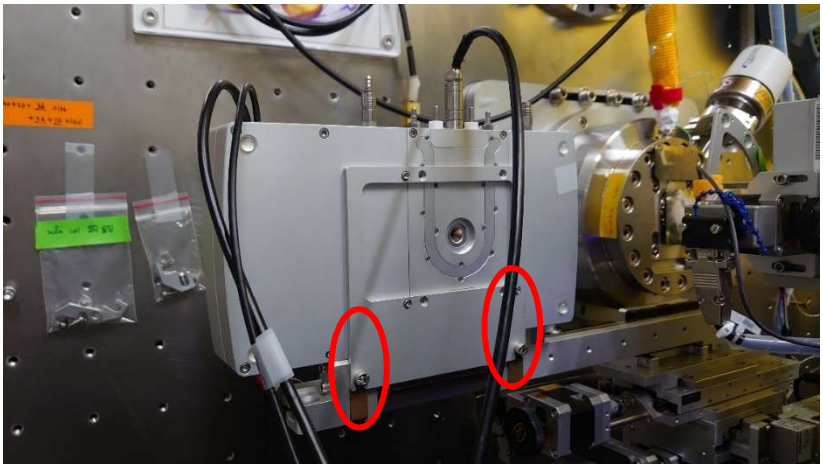


毛細管請蓋上專用蓋
避免樣品溢出或揮發

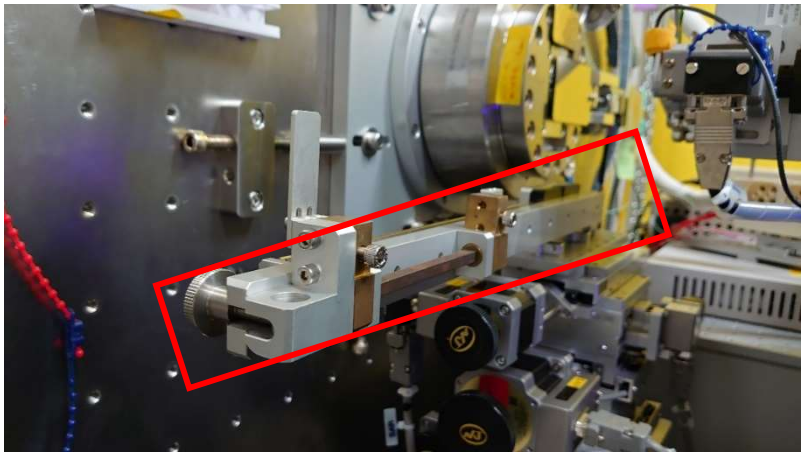
實驗完成拆除拉伸機系統



0 拉出機台，移除所有接線



1． 將底座螺絲拆除，取下拉伸座



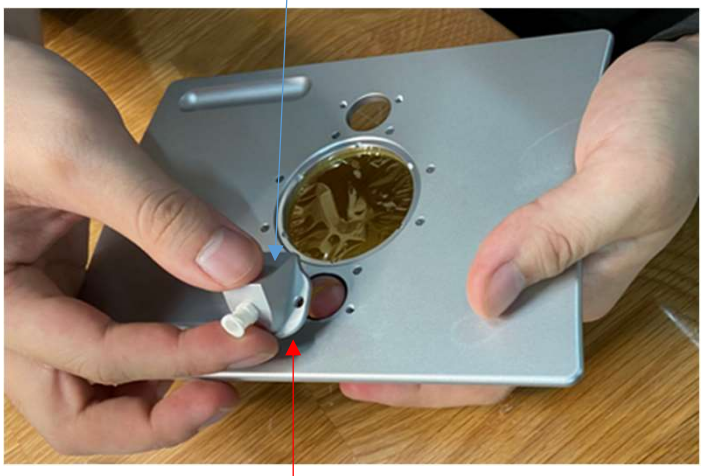
2．將拉伸機底座支架拆除

濕度控制

Product News | Microscopy Light Microscopy 16 February 2022

Linkam updates humidity control range of instruments

The RHGen relative humidity controller offers humidity control between 3% and 95% RH, at temperatures from ambient to 85°C.



LINKAM RHGEN HUMIDITY CONTROLLER

SKU:L-RH95

The RHGen Relative Humidity Controller is designed to provide environmental sample control to the range of Linkam stages. It allows precise control of water vapor in the environment around a sample **without the need for an external dry air supply**.

The smallest change in RH% can have huge implications on the characteristics of a sample and how it behaves. When combined with a Linkam stage, or other sealed chambers, the RHGen can be used to control the RH% between 5%-90% at temperatures from ambient to 85°C (dependent on device).

Unlike many other humidity systems, the feedback sensor is located close to the sample block, ensuring accurate humidity control. The RHGen can be combined with light microscopy, Raman, FT-IR and X-ray to further characterize samples.

The RHGen controller is compatible with a wide range of Linkam stages, as well as third-party devices with sealed chambers. It is supplied with a small sealed chamber as standard, which can be used with humidity validation samples.

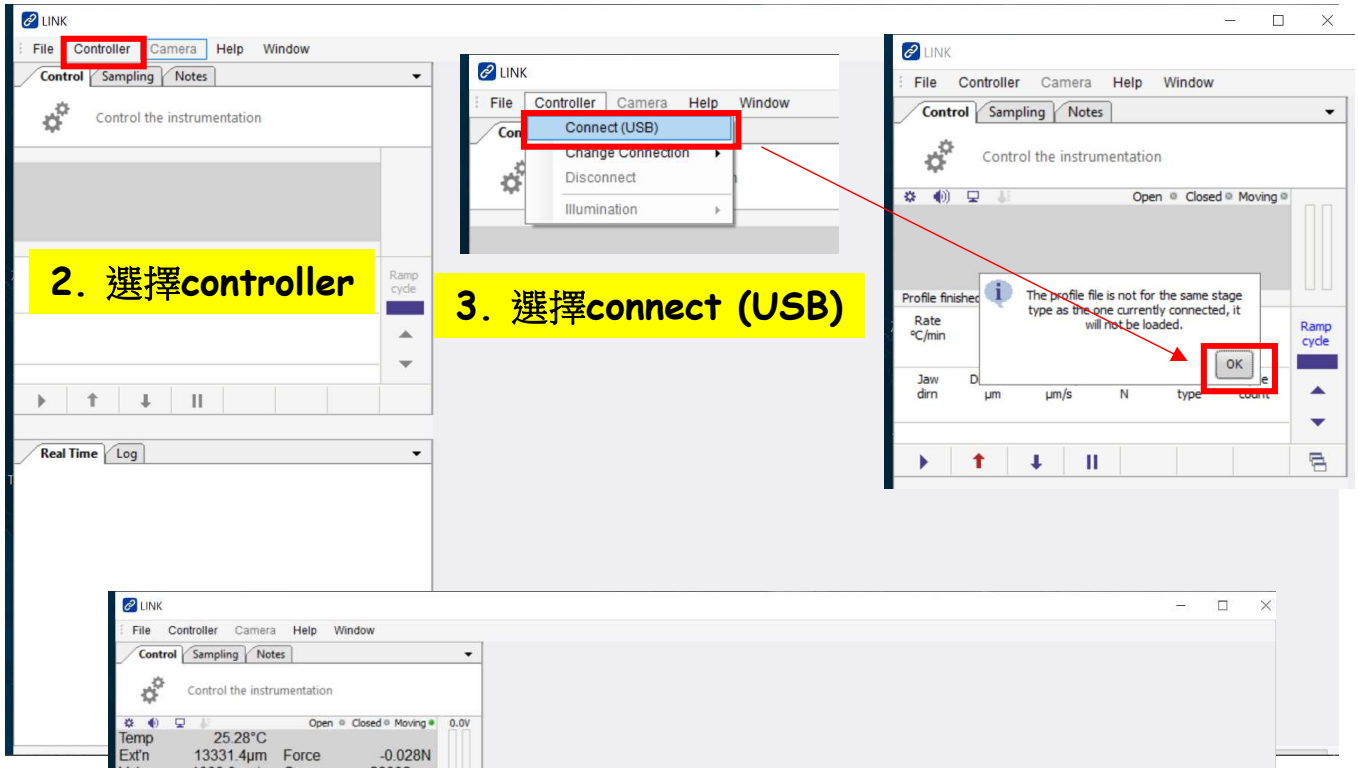
The system contains a specially designed, automated recycling desiccant system which, combined with the ability to top up the water even during a run, allows the system to provide humidity control for months at a time.

The RHGen is now available with compatible versions of the Linkam MFS, THMS600, HFS600, LTS420 stages, and more. Contact us if you need an RH compatible version of our stages.

不作濕度控制時
可移除 節省空間，讓基座靠近X-ray window

拉伸機系統軟體操作

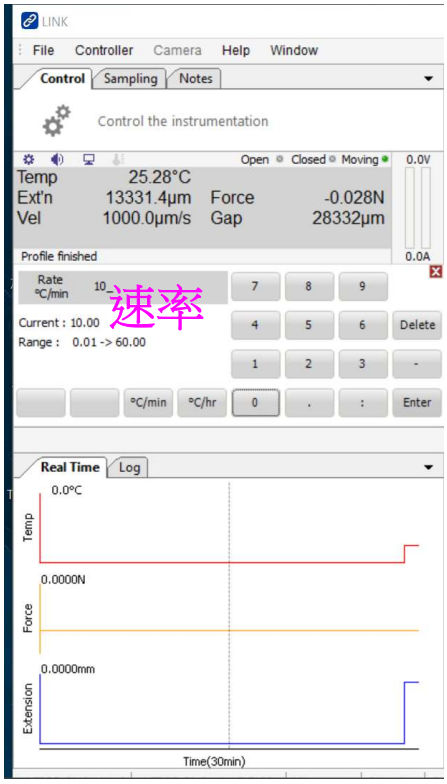

LINK
1. 開啟軟體 "LINK"

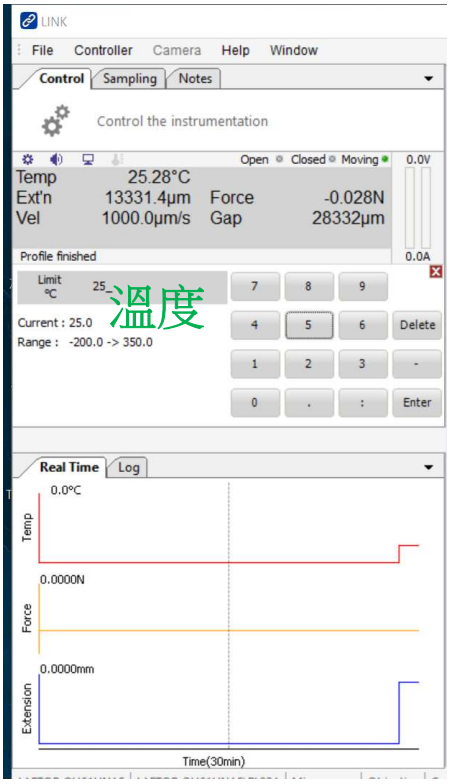

LINK
File Controller Camera Help Window
Control Sampling Notes
Control the instrumentation
Real Time Log
2. 選擇controller
Connect (USB)
Change Connection
Disconnect
Illumination
3. 選擇connect (USB)
Open Closed Moving
Profile finished
The profile file is not for the same stage type as the one currently connected, it will not be loaded.
OK
Rate °C/min
Ramp cycle
Jaw dirn
µm
µm/s
N
type

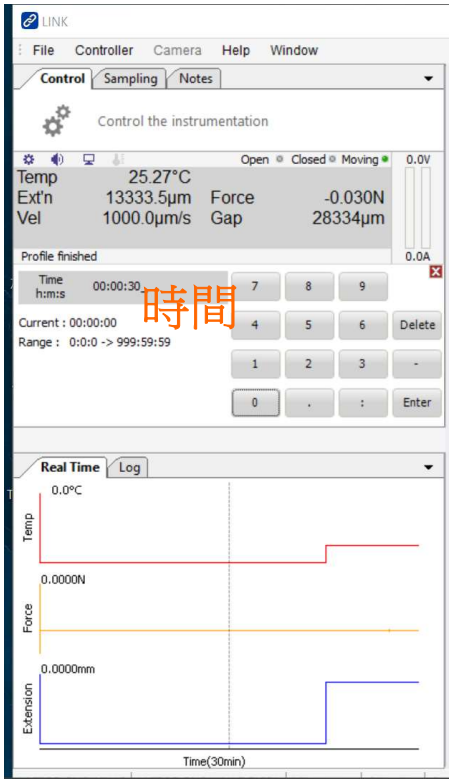

LINK
File Controller Camera Help Window
Control Sampling Notes
Control the instrumentation
Temp 25.28°C
Ext'n 13331.4µm Force -0.028N
Vel 1000.0µm/s Gap 28332µm
Profile finished
Rate °C/min
Limit °C
Time h:m:s
Lnp speed
1.00
25.0
00:00:00
Auto
Jaw dirn
Distance µm
Velocity µm/s
Force N
Move type
Cycle count
open
88000.0
0.00
0.00
none
Real Time
Log
0.0°C
Temp
0.0000N
Force
0.0000mm
Extension
Time(30min)
4. 軟體已開啟
Profile finished
Rate °C/min
Limit °C
Time h:m:s
Lnp speed
1.00
25.0
00:00:00
Auto
Jaw dirn
Distance µm
Velocity µm/s
Force N
open
88000.0
0.00
0.00
速率
溫度
時間

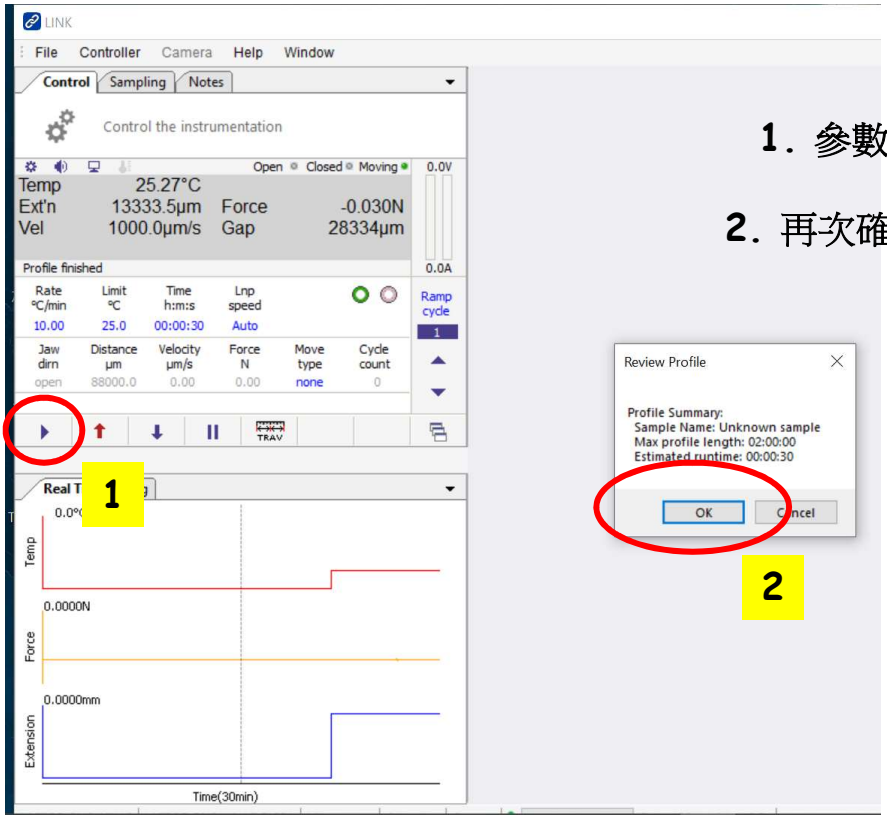
升降溫實驗參數設定

根據實驗所需條件輸入升降溫速率，溫度，時間





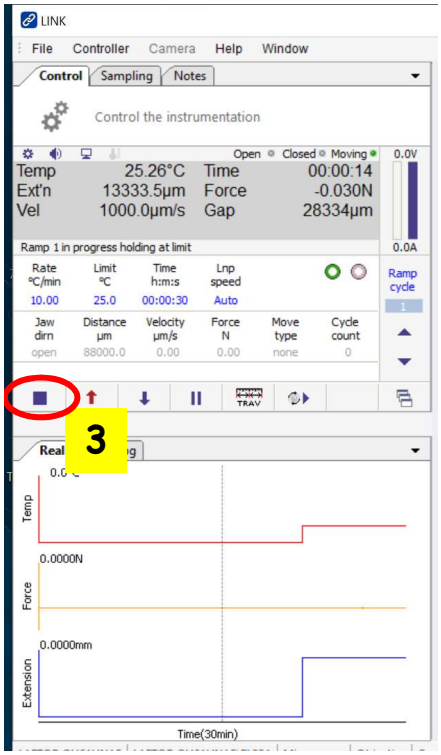


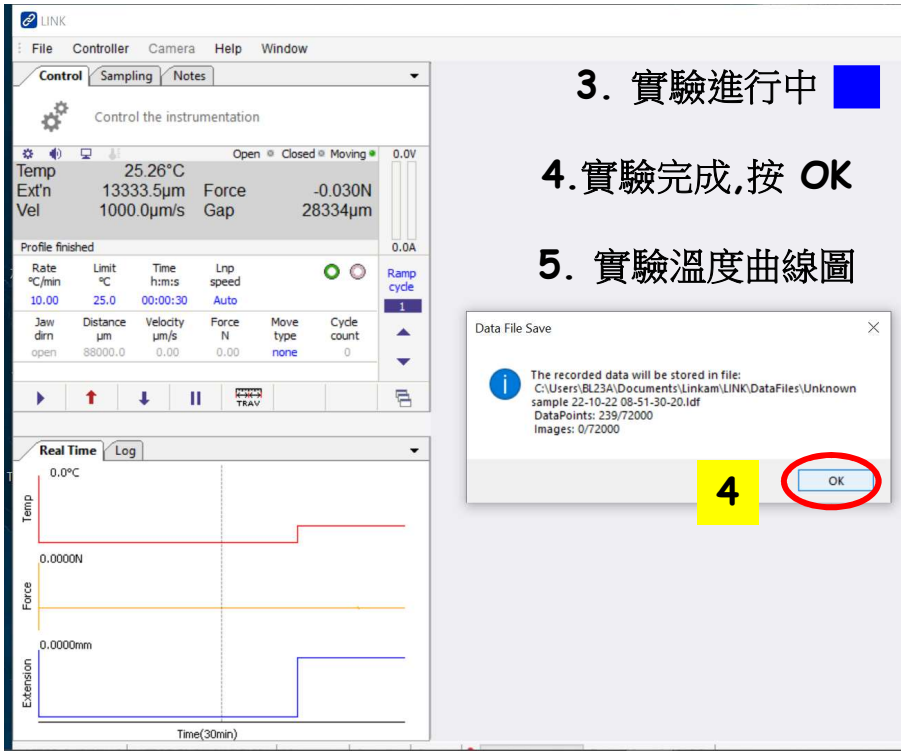


1. 參數輸入完成後,執行按 ▶

2. 再次確認實驗條件後,按 **OK**

執行實驗

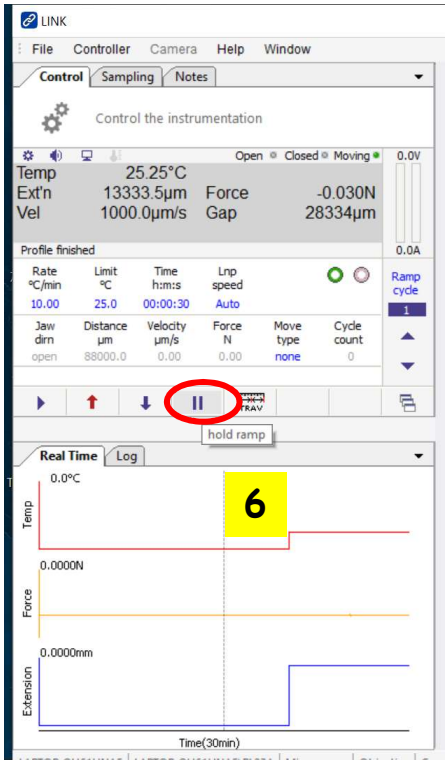


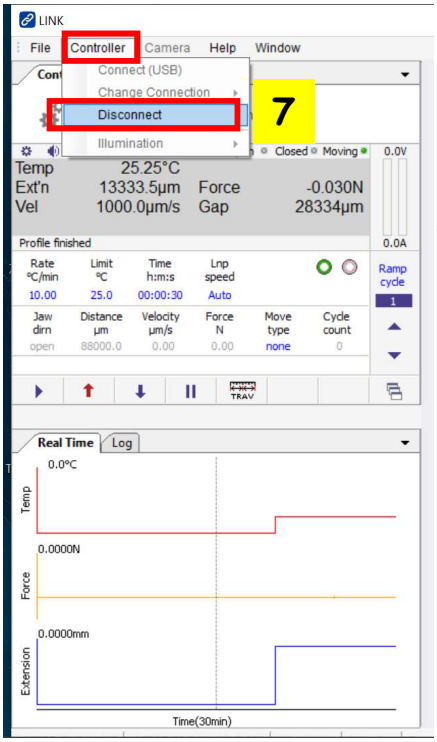


3. 實驗進行中

4.實驗完成,按 OK

5. 實驗溫度曲線圖



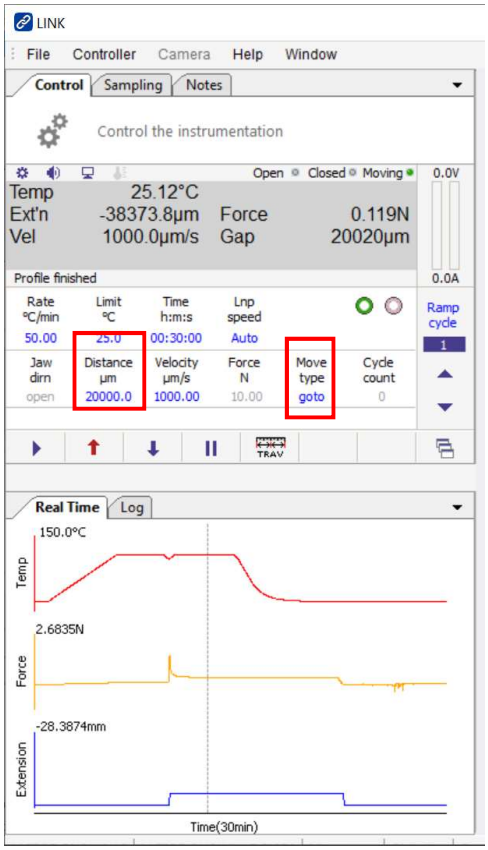


6. 實驗進行中,想暫停

7. 關閉軟體
Controller "Disconnect"

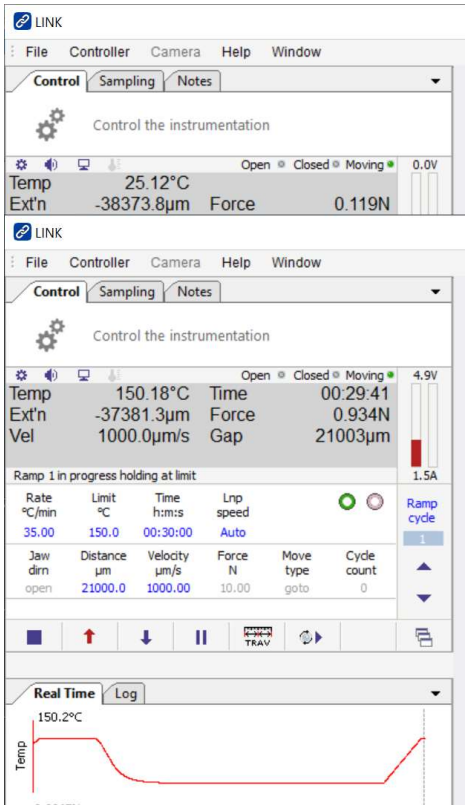
拉伸實驗操作範例

此次樣品實驗條件為在室溫25度及100度、150度，不同條件拉伸，觀察樣品saxs數據的變化

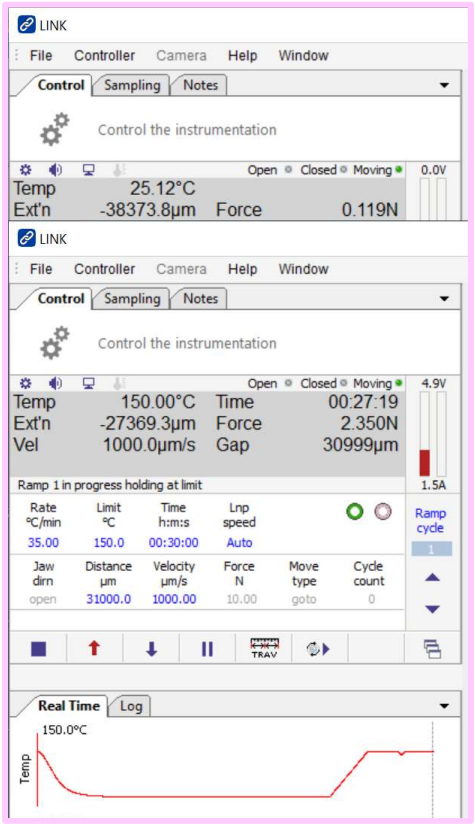


Move type ： go to
樣品起始位置: 20000 µm

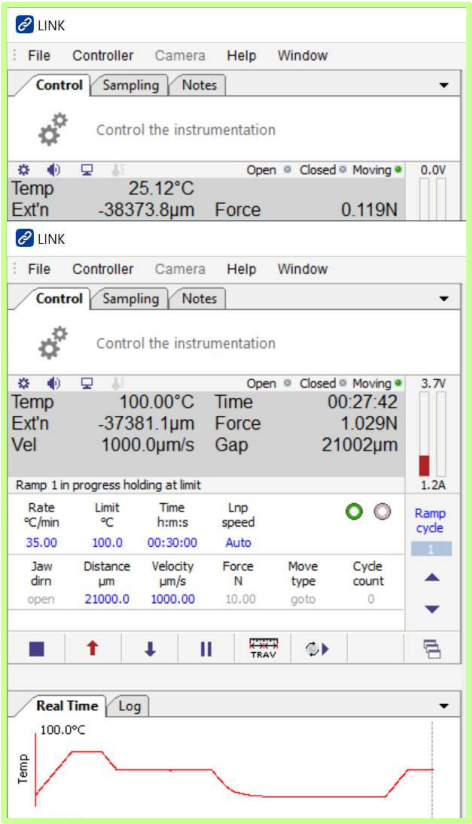
詳細操作方法請參考**page 4**



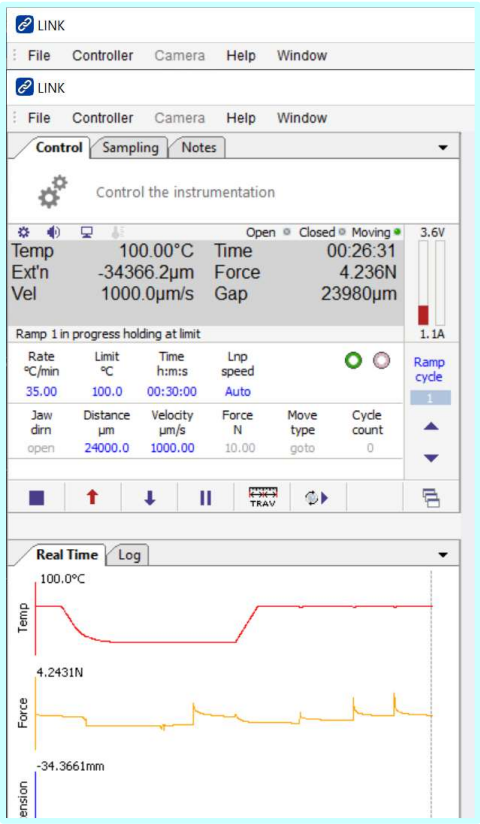
1. 設定升溫速率 ： 35 ℃/min
2. 設定溫度 ： 25℃→150℃
3. 持溫拉伸時間 ： 30 min
4. 拉伸速度: 1000 µm/s



1. 設定升溫速率：35 ℃/min
2. 設定溫度：150℃
3. 持溫拉伸時間：30 min
4. 拉伸速度：1000 µm/s
5. 拉升後距離：31000 µm



1. 設定升溫速率：35 ℃/min
2. 設定溫度：100℃
3. 持溫拉伸時間：30 min
4. 拉伸速度：1000 µm/s
5. 拉升後距離：21000 µm



1. 設定升溫速率：35 ℃/min
2. 設定溫度：100℃
3. 持溫拉伸時間：30 min
4. 拉伸速度：1000 µm/s
5. 拉升後距離：24000 µm

障礙排除

若發生無法降溫的情況

1. 確認液氮桶內有無液氮
2. 氮氣連接線位置是否正確
3. 軟體重新連線
4. 儀器重新開關

若以上確認方法皆無法排除降溫問題，
請聯絡光束線人員協助處理

LINKAM https://www.linkam.co.uk/mfs

MFS - MODULAR FORCE STAGE

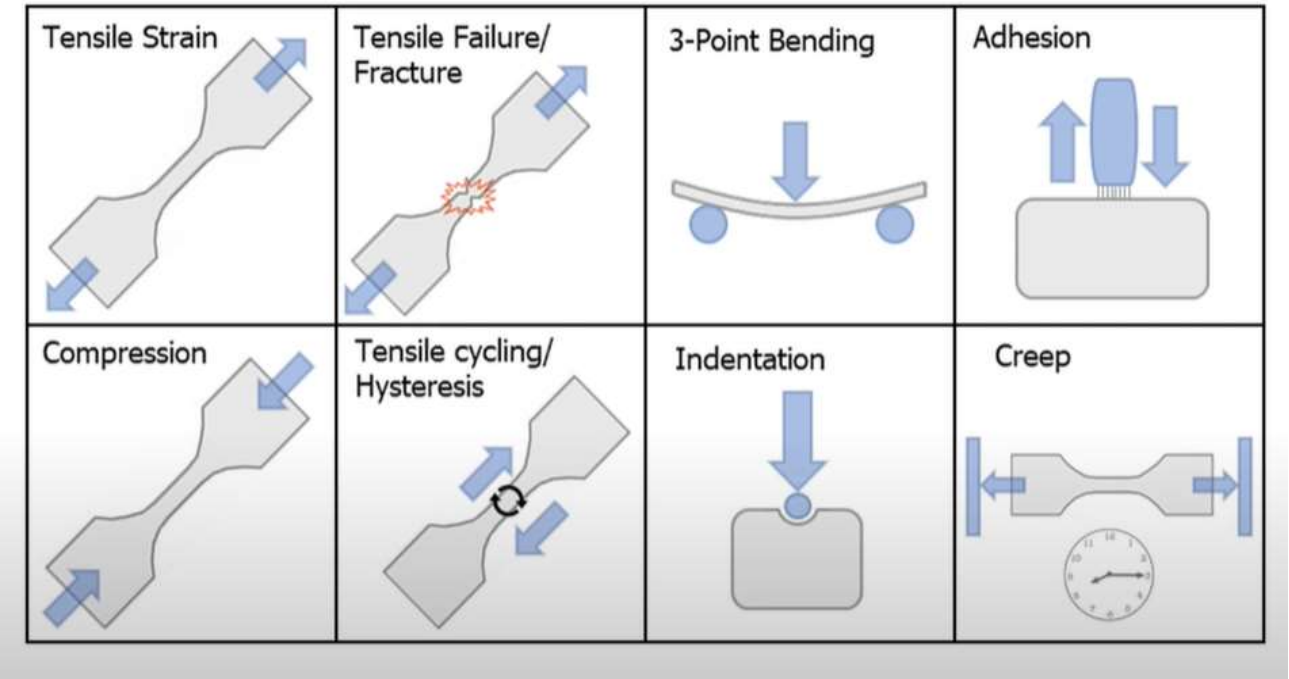
Mechanical sample characterisation with temperature and environmental control modules

MFS on Imaging station, with a sample under tension across the 350°C heater block.

Features

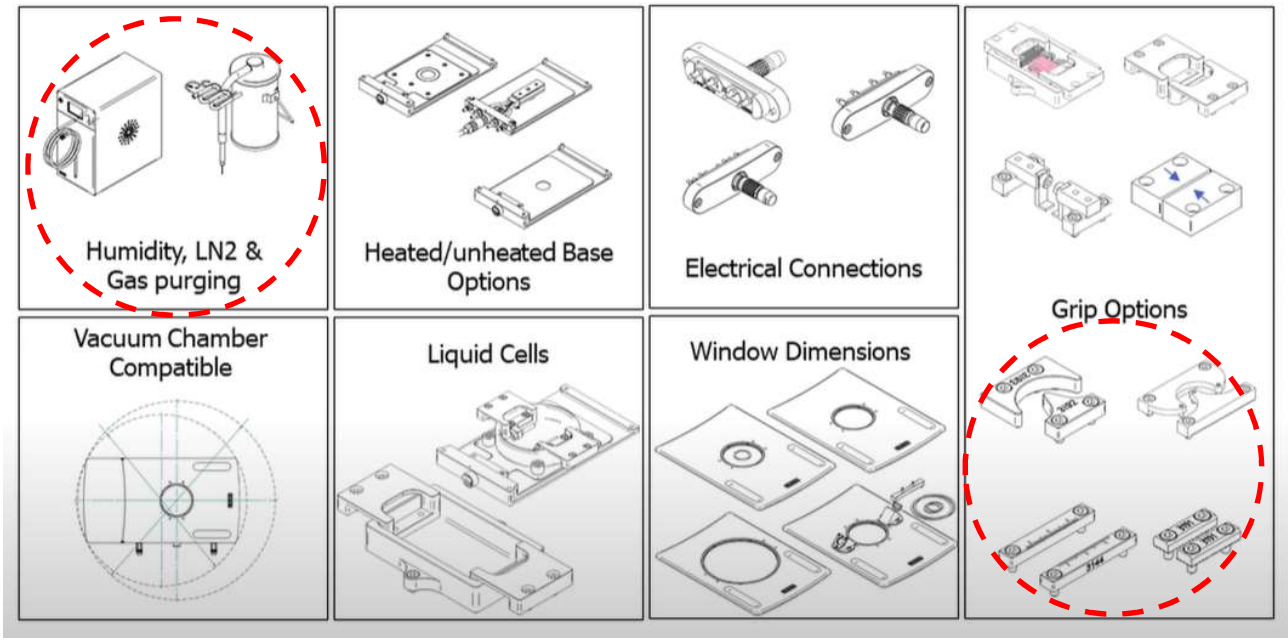
- Compression and Tensile Force: Test the compressive and tensile properties of your sample relative to temperature and capture high resolution images of the structural changes.
- Multi-point bending measurements
- Wide range of control parameters: Speed of jaws, distance moved and the force applied can be varied relative to temperature.
- Interchangeable Heaters & Grips: The temperature can be controlled from <-195°C up to 350°C depending on heater attached. Heaters and grips can be changed to accommodate a wide range of sample types.
- Electrical connections: Optional electrical connections enable electrical measurement on the sample during tensile testing.
- Humidity: Add the RH95 humidity unit to your system to accurately control the relative humidity around your samples.
- Encoded Distance Measurement: Built in high resolution encoder ensures precise measurement of changes in length.

各種測式模式；拉伸樣品製備

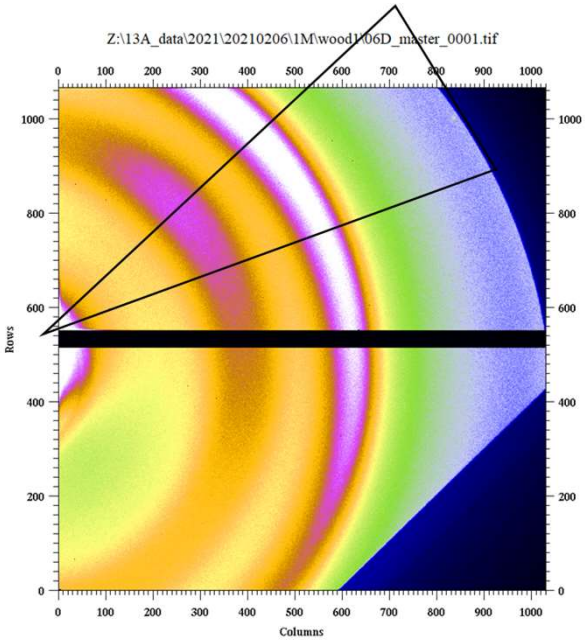


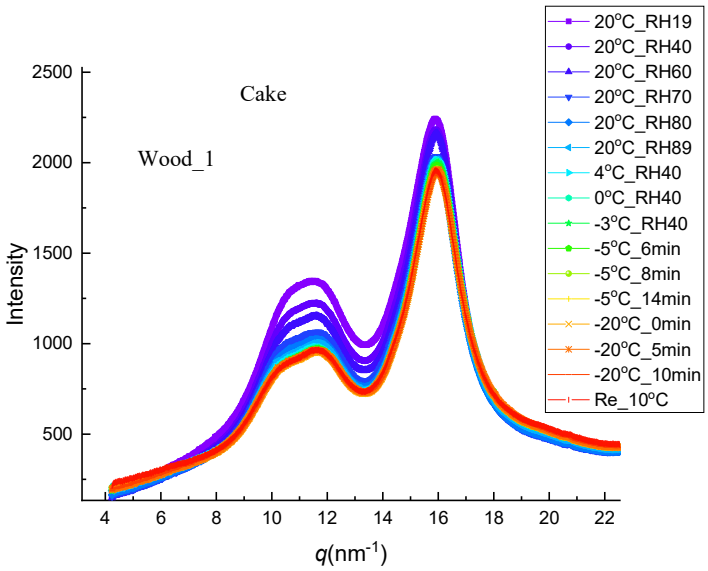
1.拉伸強度
2.斷裂模式
3.彎曲 (剪應力)
4.黏滯性
5.壓縮
6.拉伸循環
7.壓痕(凹痕)
8. 潛變（蠕變）：在應力作用下固體材料緩慢且永久的變形。

各種選配模具



Wood sample-1
SAXS/WAXS with temp. and humidity controls





Wood sample-3_20℃ →-50 ℃ (20 ℃/min)