Factory Set Programs Cookbook

PUL-1000

Microprocessor-Controlled Micropipette Puller

www.wpiinc.com
080824

CONTENTS

ABOUT THIS MANUAL

The following symbols are used in this guide:

This symbol indicates a CAUTION. Cautions warn against actions that can cause damage to equipment. Please read these carefully.

This symbol indicates a WARNING. Warnings alert you to actions that can cause personal injury or pose a physical threat. Please read these carefully.

NOTES and TIPS contain helpful information.

INTRODUCTION

PUL-1000 is a microprocessor controlled, up to four-stage, horizontal puller for making glass micropipettes or microelectrodes used in intracellular recording, patch clamp, microperfusion and microinjection. The puller was designed with tight mechanical specifications and precision electronics for complete control of the pulling process and accurate reproducibility. It offers programmable sequences of up to four steps with HEAT INDEXing, FORCE (g), movement and cooling time. This allows graduated cycles for a variety of applications.

NOTE: This is a puller educational and research purposes, not a production puller. If the puller stops in the middle of a pull as a result of overHEAT INDEXing, allow time for it to cool down.

For information on using the **PUL-1000**, please refer to the Instruction Manual found at www.wpiinc.com/manuals.

NOTE: The glass melting point is also referred to as the glass softening point.

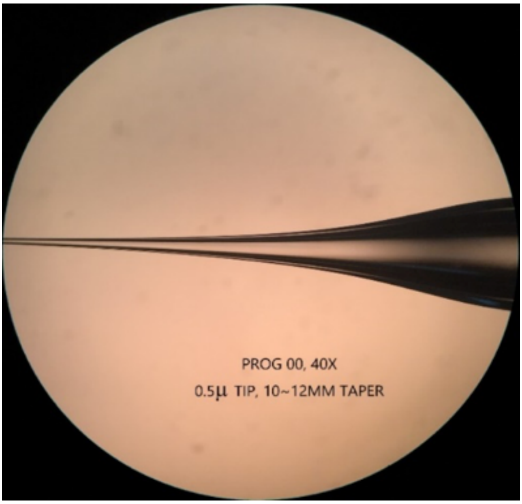
FACTORY SET PROGRAMS

Program	Glass OD (mm)	Long Graduated Taper	Short Graduated Taper	Short Taper (Bee Stinger)	Expected Ave. Tip Diameter (µm)	Glass SKU	Page
00	1.0	X			0.5~1	**1B100-4**	**3**
01	1.0		X		1~2	**1B100-4**	**4**
02	1.0			X	2~3	**1B100-4**	**5**
10	1.14	X			0.5~1	**504949**	**6**
11	1.14		X		1~2	**504949**	**7**
12	1.14			X	2~3	**504949**	**8**
20	1.2	X			0.5~1	**1B120-4**	**9**
21	1.2		X		1~2	**1B120-4**	**10**
22	1.2			X	3~4	**1B120-4**	**11**
30	1.5	X			0.5~1	**1B150-4**	**12**
31	1.5		X		1~2	**1B150-4**	**13**
32	1.5			X	2~4	**1B150-4**	**14**
40	2.0	X			0.5~1	**1B200-4**	**15**
41	2.0		X		2~4	**1B200-4**	**16**
42	2.0			X	2~4	**1B200-4**	**17**

Program 00 (Long Graduated Taper, 1.0 mm Glass)

Average glass softening point for 1 mm glass (1B100-4, Lot# 2209343) = 515°C @ ~ 66-74% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	650	250	8.00	0	Long graduated taper (tip break back needed)*
2	-	-	-	-	
3	-	-	-	-	
4	-	-	-	-	

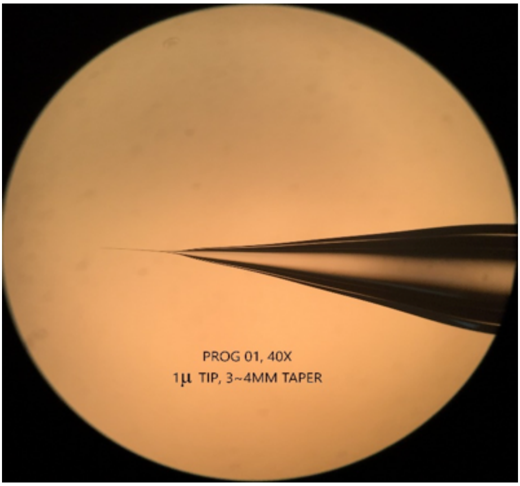


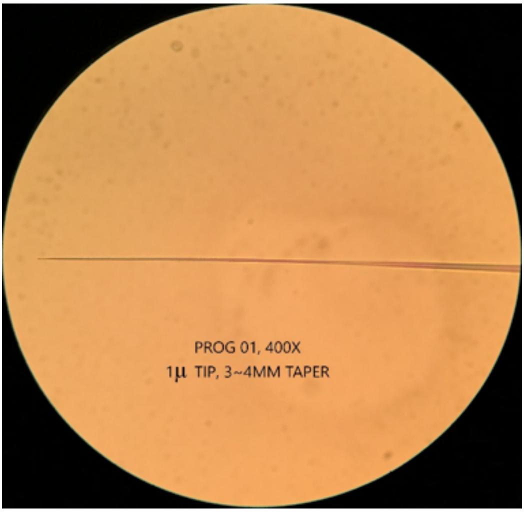
***NOTE**: To make a large tip (usually > 5 µm tip), break off the final tip. Use a breaking back technique using blades or tweezers, or drag the tip on a Kimwipe. A second process such as beveling and/or fire polishing may also be needed.

Program 01 (Short Graduated Taper, 1.0 mm Glass)

Average glass softening point for 1 mm glass (1B100-4, Lot# 2209343) = 515°C @ ~ 66-74% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	650	250	2.00	100	
2	400	300	7.00	0	Short graduated taper
3	-	-	-	-	
4	-	-	-	-	

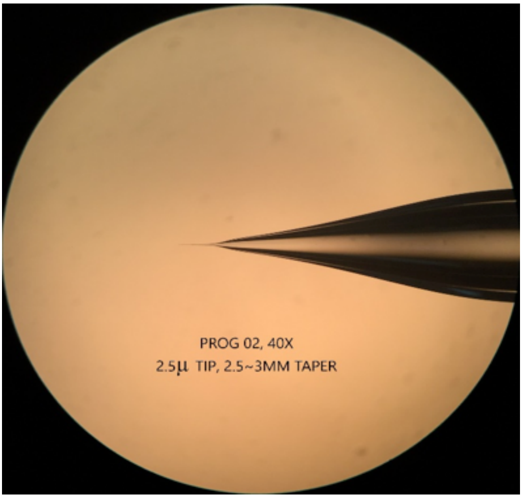


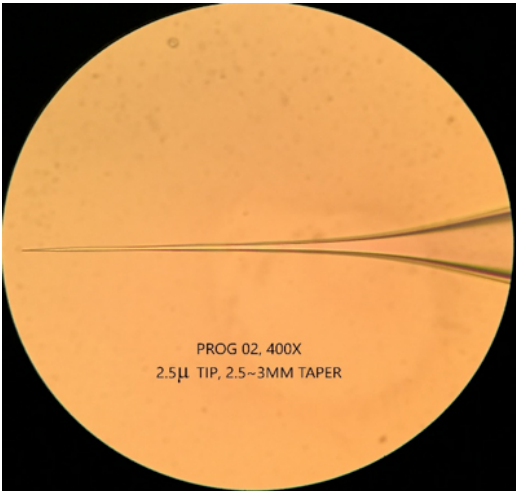


Program 02 (Short Taper, 1.0 mm Glass)

Average glass softening point for 1 mm glass (1B100-4, Lot# 2209343) = 515°C @ ~ 66-74% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	-	-	-	-	
2	-	-	-	-	
3	-	-	-	-	
4	510	250	0.60	100	Short taper (bee stinger)

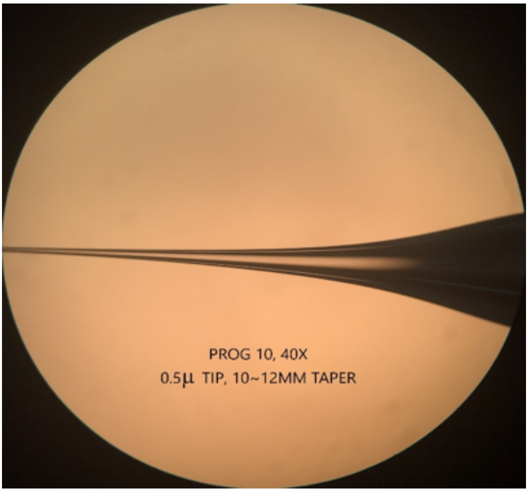


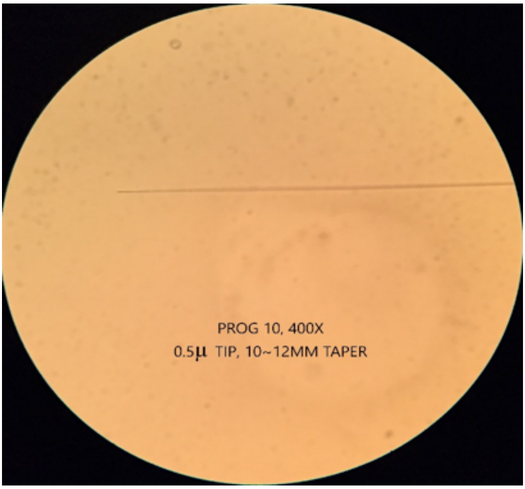


Program 10 (Long Graduated Taper, 1.14 mm Glass)

Average glass softening point for 1.14 mm glass (504949, Lot# 02K) = 576°C @ ~ 66-74% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	650	250	8.00	0	Long graduated taper (tip break back needed)*
2	-	-	-	-	
3	-	-	-	-	
4	-	-	-	-	



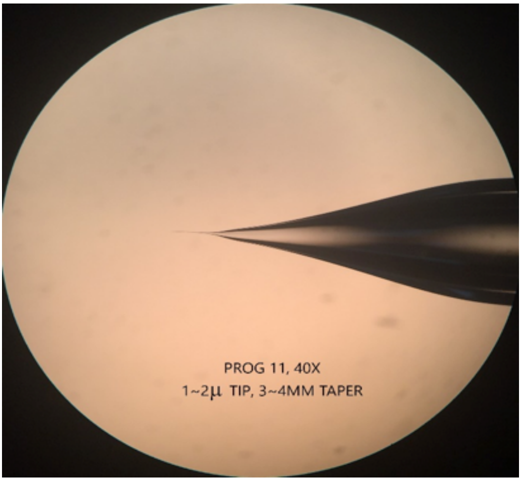


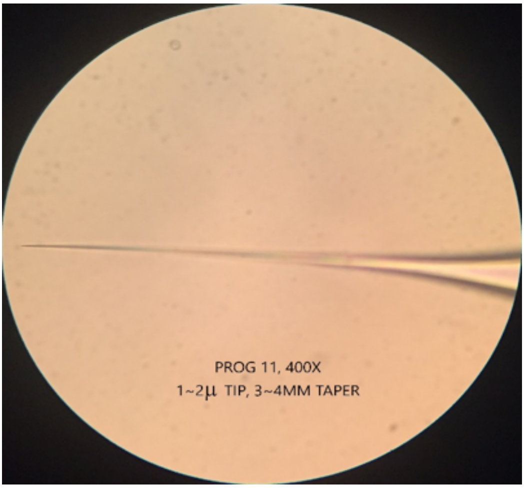
***NOTE**: To make a large tip (usually > 5 µm tip), break off the final tip. Use a breaking back technique using blades or tweezers, or drag the tip on a Kimwipe. A second process such as beveling and/or fire polishing may also be needed.

Program 11 (Short Graduated Taper, 1.14 mm Glass)

Average glass softening point for 1.14 mm glass (504949, Lot# 02K) = 576°C @ ~ 66-74% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	650	250	2.00	100	
2	410	300	7.00	0	Short graduated taper
3	-	-	-	-	
4	-	-	-	-	

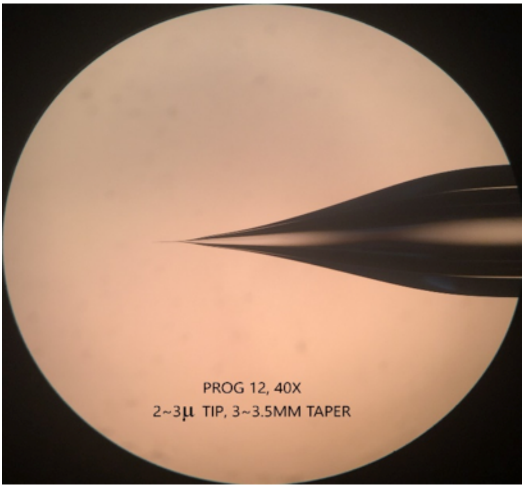


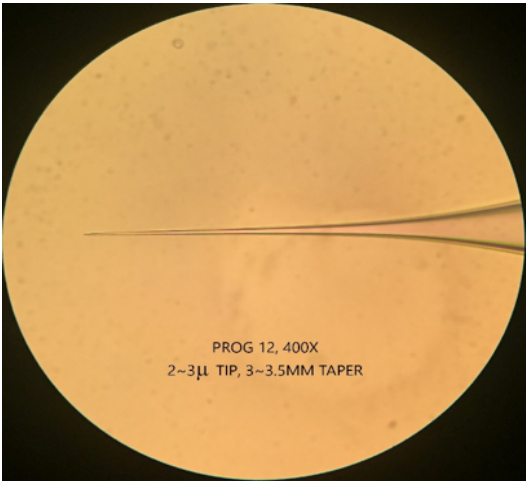


Program 12 (Short Taper, 1.14 mm Glass)

Average glass softening point for 1.14 mm glass (504949, Lot# 02K) = 576°C @ ~ 66-74% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	-	-	-	-	
2	-	-	-	-	
3	-	-	-	-	
4	485	250	0.60	100	Short taper (bee stinger)

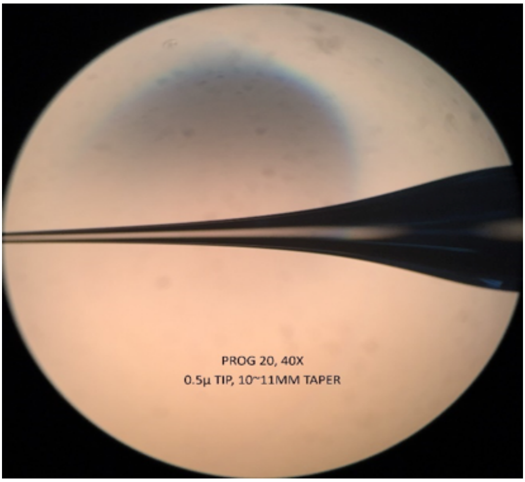


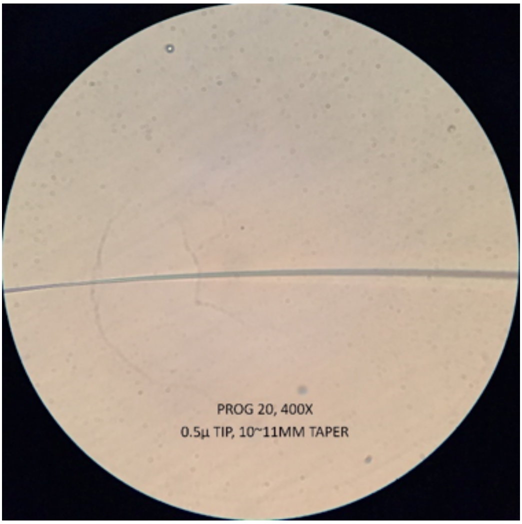


Program 20 (Long Graduated Taper, 1.2 mm Glass)

Average glass softening point for 1.14 mm glass (1B120-4, Lot# 04J) = 517°C @ ~ 59-67% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	650	250	8.00	0	Long graduated taper (tip break back needed)*
2	-	-	-	-	
3	-	-	-	-	
4	-	-	-	-	



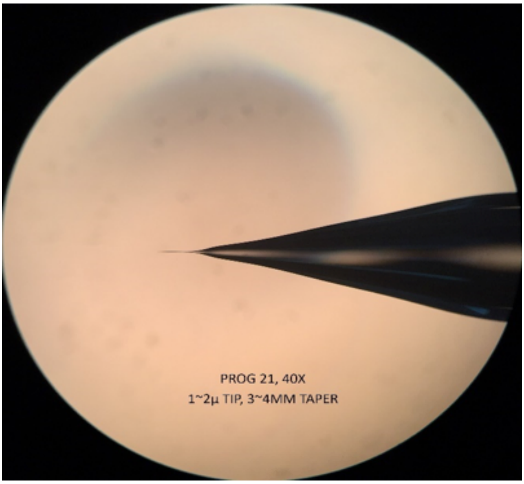


***NOTE**: To make a large tip (usually > 5 µm tip), break off the final tip. Use a breaking back technique using blades or tweezers, or drag the tip on a Kimwipe. A second process such as beveling and/or fire polishing may also be needed.

Program 21 (Short Graduated Taper, 1.2 mm Glass)

Average glass softening point for 1.14 mm glass (1B120-4, Lot# 04J) = 517°C @ ~ 59-67% humidity and ~70-73°F

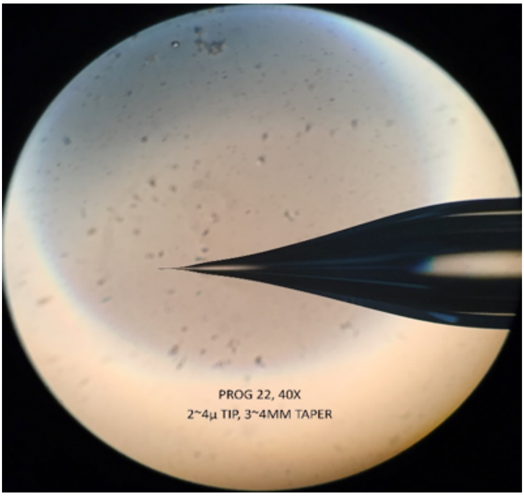
STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	650	250	2.00	100	
2	370	300	7.00	0	Short graduated taper
3	-	-	-	-	
4	-	-	-	-	

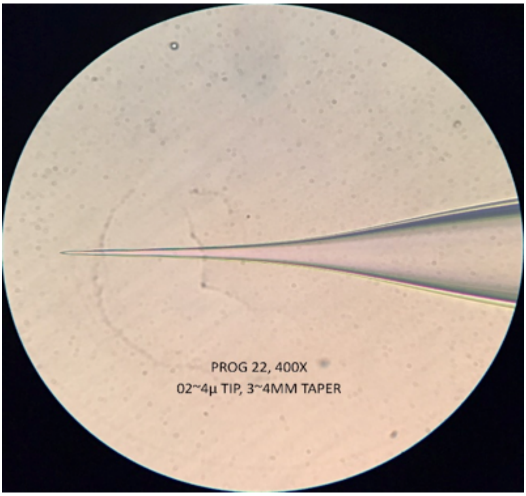


Program 22 (Short Taper, 1.2 mm Glass)

Average glass softening point for 1.14 mm glass (1B120-4, Lot# 04J) = 517°C @ ~ 59-67% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	-	-	-	-	
2	-	-	-	-	
3	-	-	-	-	
4	430	250	0.60	100	Short taper (bee stinger)

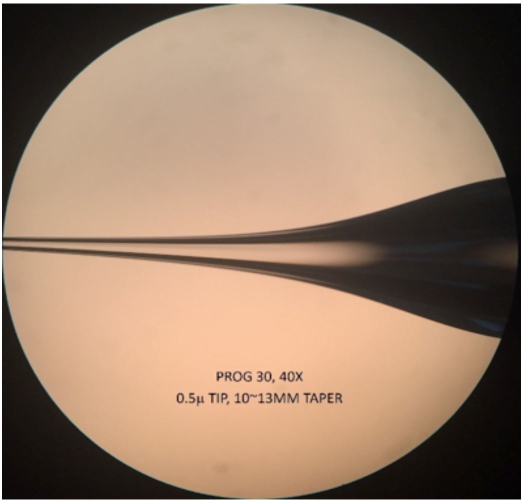


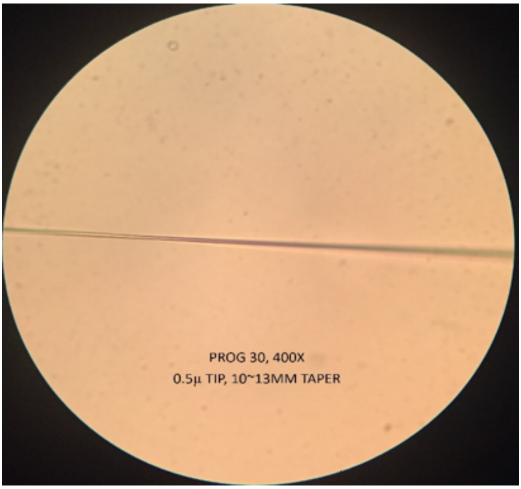


Program 30 (Long Graduated Taper, 1.5 mm Glass)

Average glass softening point for 1.5 mm glass (1B150-4, Lot# 2208332) = 629°C @ ~ 61-70% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	700	250	8.00	0	Long graduated taper (tip break back needed)*
2	-	-	-	-	
3	-	-	-	-	
4	-	-	-	-	



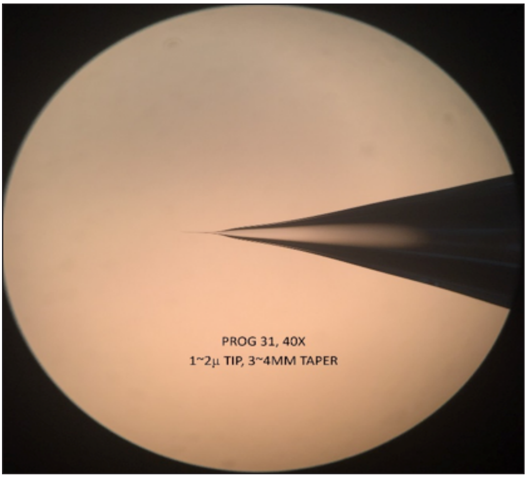


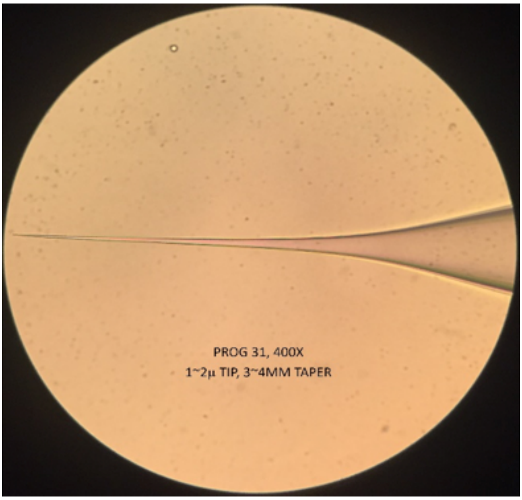
***NOTE**: To make a large tip (usually > 5 µm tip), break off the final tip. Use a breaking back technique using blades or tweezers, or drag the tip on a Kimwipe. A second process such as beveling and/or fire polishing may also be needed.

Program 31 (Short Graduated Taper, 1.5 mm Glass)

Average glass softening point for 1.5 mm glass (1B150-4, Lot# 2208332) = 629°C @ ~ 61-70% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	700	250	2.00	100	
2	440	300	7.00	0	Short graduated taper
3	-	-	-	-	
4	-	-	-	-	

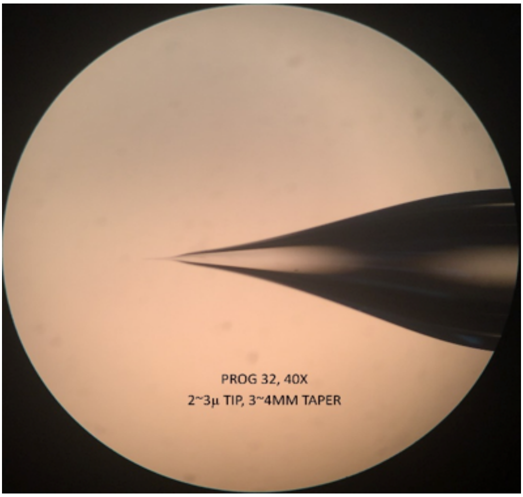


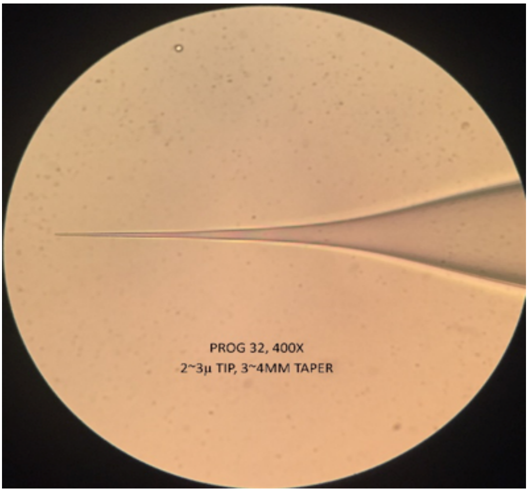


Program 32 (Short Taper, 1.5 mm Glass)

Average glass softening point for 1.5 mm glass (1B150-4, Lot# 2208332) = 629°C @ ~ 61-70% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	-	-	-	-	
2	-	-	-	-	
3	-	-	-	-	
4	500	250	0.60	100	Short taper (bee stinger)

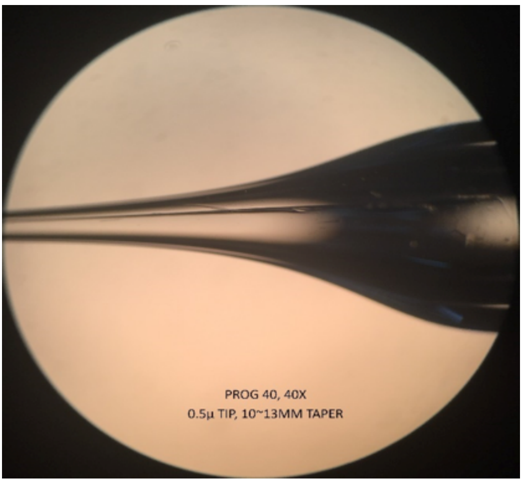


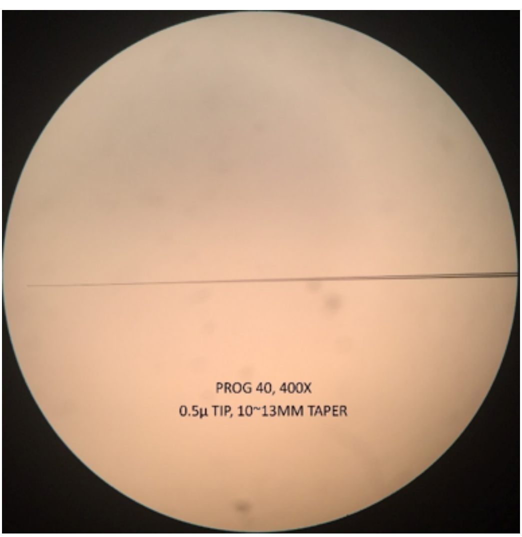


Program 40 (Long Graduated Taper, 2.0 mm Glass)

Average glass softening point for 2.0 mm glass (1B200-4, Lot# 2108325) = 645°C @ ~ 61-70% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	750	250	8.00	0	Long graduated taper (tip break back needed)*
2	-	-	-	-	
3	-	-	-	-	
4	-	-	-	-	



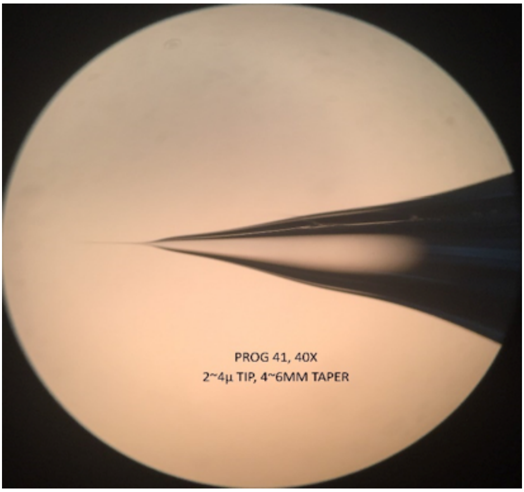


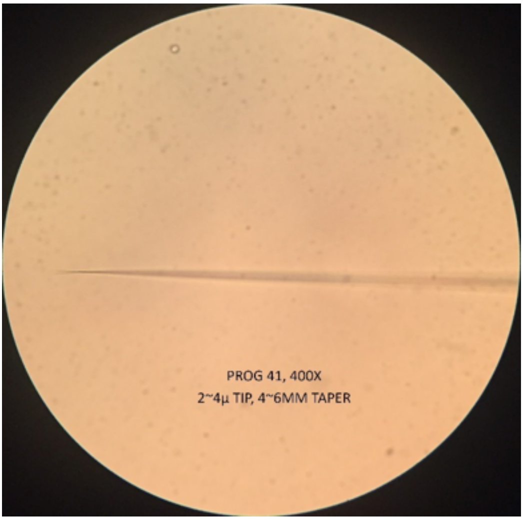
***NOTE**: To make a large tip (usually > 5 µm tip), break off the final tip. Use a breaking back technique using blades or tweezers, or drag the tip on a Kimwipe. A second process such as beveling and/or fire polishing may also be needed.

Program 41 (Short Graduated Taper, 2.0 mm Glass)

Average glass softening point for 2.0 mm glass (1B200-4, Lot# 2108325) = 645°C @ ~ 61-70% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	750	250	3.50	100	
2	470	350	7.00	0	Short graduated taper
3	-	-	-	-	
4	-	-	-	-	

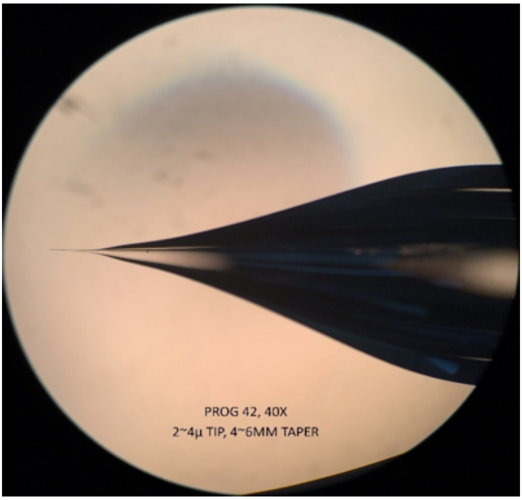


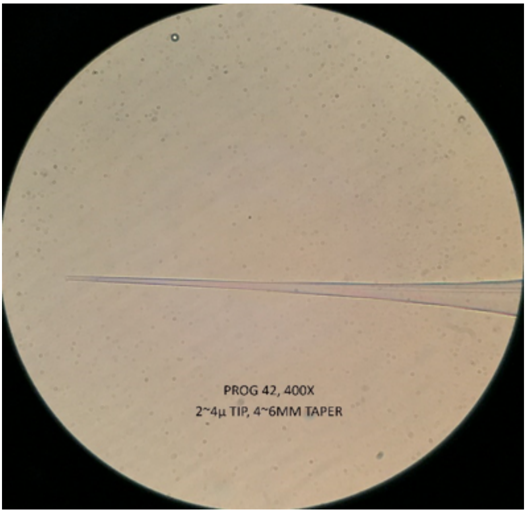


Program 42 (Short Taper, 2.0 mm Glass)

Average glass softening point for 2.0 mm glass (1B200-4, Lot# 2108325) = 645°C @ ~ 61-70% humidity and ~70-73°F

STEP	HEAT INDEX	FORCE (g)	DISTANCE (mm)	DELAY (0.1 s)	TIP GEOMETRY
1	-	-	-	-	
2	-	-	-	-	
3	-	-	-	-	
4	590	400	0.80	100	Short taper (bee stinger)





BACKGROUND INFORMATION

The glass transition is the gradual and reversible transition from a hard and relatively brittle solid state into a soft and viscous state as the temperature increases. To form glass into certain shapes using a puller, heat is applied through a filament. There are three methods to transfer heat:

- Direct conduction in solids
- Convection of air
- Radiation through anything that will allow radiation to pass.

Many factors affect the heat transferred from a filament to a glass capillary. The filament holders is heated up when current passes through the filament. Also the heat from the surface of filament is conducted to filament holders. So, as the puller use continues, the temperate of filament holders increases. To reduce the heat residue built-up both in the filament and the filament holders, it takes time for the colder ambient air to cool the filament and the filament holders.

The convection of air in the ambient environment (both inside and outside of the cover chamber) affects the heat transfer from the filament to the glass. So, room temperature and humidity (in other word, density) affect the glass transition.

The heat radiating from the filament to the glass play the most important role in the glass transition. The distance between the surface of the glass and the surface of the filament depends on the amount of heat transferred. That is the reason why it is important to make sure the glass is placed at the center of the filament. All facets of glass should be heated evenly.

The filament is made of a platinum/iridium alloy. Even though platinum/iridium alloy is one of the most inert substances in the heating material market, it is still slowly oxidized by the oxygen from air. The mass of platinum/iridium alloy is reduced as the puller is used. It will eventually burn out. Thus, the temperature changes constantly.

Different glass capillaries with different outside diameters (OD) vary in their glass softening points/temperatures. Variations of glass constituents among different glass capillary products show variations in their softening points. And, there is some variation of softening points of same glass capillary products taken from different lots. Some of our glass capillary product pulling sequences and results are shown above. You may need to make some fine adjusts of the pulling sequence parameters based on the glass capillary product you use and your laboratory environmental conditions (temperature and humidity).

As a rule of thumb, the parameters (Heat, Force, Distance, and Delay) can be altered accordingly to achieve desired shapes and dimensions of pre-pulled pipettes.

The table below shows basic guidelines for setting up a sequence.

PARAMETER	INCREASE (↑)	DECREASE (↓)
Heat	Longer Taper	Shorter Taper
Force	Smaller Tips, Longer Taper	Larger Tips, Shorter Taper
Distance	Smaller Tips	Larger Tips
Delay	Shorter Taper	Longer Taper

Fig. 1—Effect of different parameters on pre-pulled pipette shapes and dimensions.

NOTE: To make a large tip (usually > 5 µm tip), break off the final tip. Use a breaking back technique using blades or tweezers, or drag the tip on a Kimwipe. A second process such as beveling and/or fire polishing may also be needed.

MY CUSTOM SEQUENCES

NAME: ____________________ **PROGRAM #:** __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ____________________ **PROGRAM #:** __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ____________________ **PROGRAM #:** __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ____________________ **PROGRAM #:** __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ______________________ **PROGRAM #:** __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ______________________ **PROGRAM #:** __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ______________________ **PROGRAM #:** __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ______________________ **PROGRAM #:** __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ______________________ **PROGRAM #:** __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ____________________ PROGRAM #: __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ____________________ PROGRAM #: __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ____________________ PROGRAM #: __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ____________________ PROGRAM #: __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ____________________ PROGRAM #: __________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ______________________ PROGRAM #: ____________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ______________________ PROGRAM #: ____________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ______________________ PROGRAM #: ____________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ______________________ PROGRAM #: ____________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ______________________ PROGRAM #: ____________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ____________ PROGRAM #: ____________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ____________ PROGRAM #: ____________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ____________ PROGRAM #: ____________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ____________ PROGRAM #: ____________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

NAME: ____________ PROGRAM #: ____________

STEP	HEAT	FORCE	DISTANCE	DELAY
1				
2				
3				
4				

WORLD
PRECISION
INSTRUMENTS