Higher Flow Rate Operation Using TaperTips™

Introduction

Traditionally, commercial electrospray ionization (ESI) mass spectrometers utilize flow rates from tens of microliters per minute (10 µL/min) to milliliters per minute (1 mL/min). Because of the relatively large volume of liquid exiting the emitter, aerosol formation must be assisted by pneumatic nebulization and/or by thermal heating in an effort to obtain a stable spray. The efficiency of ionization, however, improves as the flow rate is lowered and a lower volume of mobile phase passes through the emitter, producing smaller aerosol droplets. Working at the lower flow rates of nanoliters per minute (below 500 nL/min) is commonly referred to as “nanospray” and has become a popular method employed in protein analysis. The lower flow rates in nanospray also allow for longer analysis time, providing opportunity to perform novel mass spectrometer scan functions and obtain structural information of an analyte.

New Objective manufactures PicoTip® emitters to operate with flow rates from 20 nL/min to 3µL/min. While flow rates from 10 to 500 nL/min are best served by SilicaTip™ emitters, TaperTip™ emitters have been developed to bridge the gap between traditional electrospray and nanospray techniques. TaperTips give exceptional performance from 200 nL/min to 3 µL/min, making them ideal for researchers who want to make the transition into nanospray or for experienced nanospray researchers looking for the flexibility of operating at higher flow rates.

TaperTips are designed with an external taper similar to SilicaTips, but without an accompanying internal taper (Figure 1). This unique design eliminates restrictions to flow, making the emitter extremely robust and less prone to particle clogging while providing the peak performance associated with SilicaTips.

TaperTips can be implemented with any mounting hardware designed to handle fused-silica ESI components. Users of the PicoView® series or adapter models ADPT-LTQ or ADPT-PRO can take full advantage of operation at these higher flow rates with the proper choice of TaperTip.

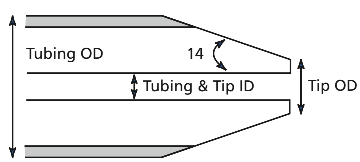


FIGURE 1 TaperTip™ emitter

Coating options

TaperTips™ are available either uncoated or coated. While many users obtain suitable performance with our standard coating (-CE- in the stock number), some find that the emitter performance can be compromised by excessive arcing during tuning due to an overvoltage condition. Although great improvements have been made with emitter coatings, constant arcing may still damage a coated tip, reducing or preventing stable operation. A good solution for those experiencing tuning problems is to use emitters with a distal coating (-D- in the stock number). The high-voltage contact is made through a junction-style contact inside the PEEK™ union. Since the distal coating is only applied to the non-tip end of the emitter, it is immune to arcing.

Mounting

Distal-coated TaperTips™ are mounted identically to distal-coated SilicaTips™. Follow the mounting instructions for junction contact provided in the manual supplied with your mounting system hardware.

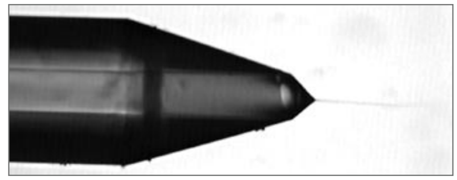
Tuning

TaperTips™ will typically employ a higher applied voltage to maintain electrospray ionization compared to other fused-silica PicoTips™. For example, a 50 μm ID TaperTip running at 1 μL/min may require an applied voltage in excess of 3.5 kV. Figure 2 provides an example of Taylor cone performance under different tuning parameters.

Troubleshooting

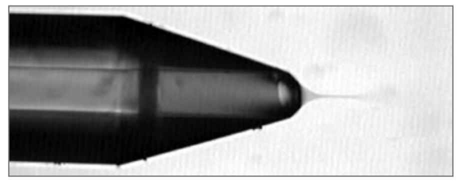
A repeating dropout of ion current
TaperTips™ operate in an intermediate flow range, which may require some special attention to find an optimal electrospray potential. A less-than-optimal applied voltage and/or flow rate may lead to a dropout in ion current and may require some fine tuning. Start by adjusting the voltage up or down in 100-volt increments. If instability persists, set the voltage at a "moderate" level where a signal (albeit unstable) is obtained, then turn off the pumping system. If good stability is observed as the pressure bleeds off, it is a good indication that the flow rate is too high. Reduce the system flow rate 25–50% and repeat the tuning procedure. If turning the pump off does not produce a stable signal, increase the system flow rate 25–50%. Figure 2 shows some of the possible modes of ESI emission. Optimal signal is usually obtained with a stable Taylor cone, which also produces smaller droplets with the highest charge-to-mass ratio for efficient desolvation.

An erratic drop in ion intensity caused by gas bubbles in the system
Gas bubbles can wreak havoc with spray stability, as pictured in Figure 3. Small bubbles can originate from trapped air pockets within a coupling union, electrolysis at the high-voltage contact, or dissolved gasses in the solvent. Bubbles can be minimized by making certain all fittings are sufficiently gas- and liquid-tight. Allow time for any residual gas to bleed out of the system. If air bubbles persist,
try using a TaperTip™ with a smaller inner diameter than that of the transfer line. This can create sufficient back-pressure and reduce or eliminate outgassing from solvents and electrolysis.



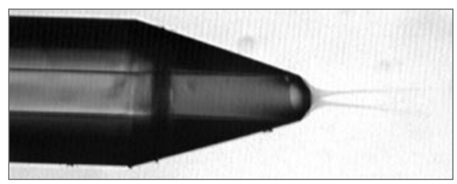
1 μl/min @ 2800 V
Excellent stability, optimal signal; stable Taylor cone

Decrease voltage



1 μl/min @ 2500 V
Reasonable stability, decreased signal; jet plus droplets

Increase flow rate



3 μl/min @ 2800 V
Diminished stability; multiple jets plus droplets

FIGURE 2 Taylor cone performance of a 50 μm distal-coated TaperTip™ (TT360-50-5-D), pumped with 75% MeOH, 2% HOAc, having a counter-electrode distance of about 6.5 mm

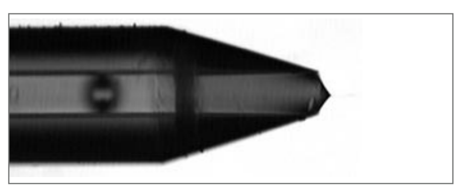


FIGURE 3 A stability-reducing gas bubble flowing toward the end of a TaperTip™

Product Specifications

TT	360	-	20	-	50	-	CE	-	5
TIP TYPE	TUBING OUTER DIAMETER		TUBING INNER DIAMETER AND TIP SIZE		TUBING LENGTH		COATING TYPE		NUMBER OF TIPS PER BOX

See our catalog or Web site for available sizes and coating options for TaperTip™ emitters.

If you ordered the TaperKit-360, you have been supplied with five tips:

Order Number	Tubing OD	Tip ID	Quantity
TT360-20	360 µm	20 µm	2
TT360-50	360 µm	50 µm	1
TT360-75	360 µm	75 µm	1
TT360-100	360 µm	100 µm	1