

NMR Probes & Accessories Catalog

Florine Quad H/F/X/Y Solids/Liquids MAS High Temperature MAS Liquids PFG/Diffusion Liquids HR High Temp Liquids and PFG Operando



OTY ENTIFIC 2025

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SCIENTIFIC

PAGE



NB H/X or H-F/X MAS Probes

Narrow bore (standard bore) ¹H/X or ¹H-19F/X (with the ¹H-¹⁹F channel tunable from ¹H to ¹⁹F)

These 2 channel probes at lower fields have a simpler design so they can be offered at lower cost. They still have the great S/N, RF field strength, and Extended Temperatures you have come to expect from Doty Probes.

- For Frequencies up to 600 MHz
- High-Q solenoid for H/X
- Multinuclear X channel tunable with tuning wands. These include ³¹P, ¹³C, ⁷⁹Br, ²⁹Si, and ¹⁵N.
- Standard VT Range

 -80°C to +120°C for NB
 Extended VT (XVT) Range
 -160°C to +150°C for NB
- Choice of 3 mm, 4mm, or 5 mm spinner





No-E, NB H/X/Y or H/F/X, even H/F/X/Y MAS

H/X/Y up to 1300 MHz

- Low E ¹H Coil
- High-Q solenoid for X and Y
- Highest S/N:

4 mm ¹³C: S/N of 205:1 on 50 mg of Glycine 3 mm ¹³C: S/N of 103:1 on 18 mg of Glycine S/N of 258:1 on 18 mg of HMB

• Highest rf Field Strength and Efficiency:

 13 C $\pi/2$ pulse of 1.3 μ s with only 640 W at 125.7 MHz. 3 mm with H/X tuning.

Wide VT Ranges
 Standard VT Range

 -80°C to +120°C for NB
 Extended VT Range

-160°C to +150°C for NB



3 mm No-E MAS with low-E outer decoupling coil, and inner X/Y solenoid.

Spectra Using a Doty XC 4 mm, 800 MHz Triple-Resonance H/X/Y Probe in a Bruker AVANCE 800

H/C tuning, glycine, 90 KHz decoupling at 230 W. HH Contact at 160 W ¹H.



Artifact free MQMAS 2D spectrum on 5/2 ²⁷Al transition of kyanite at 500 MHz.

Spectrum: Mike Frey (Jeol) and Doty Scientific.





No-E 1200 MHz XVT ¹H-¹⁹F/X/Y Probe

The 1200 MHz 5 mm ¹H-¹⁹F/X/Y probe shown here is Wideline, but MAS is also available

- High Performance Triple Resonance Circuit ¹H/X/Y or ¹H-¹⁹F/X/Y with the proton channel tunable from ¹H to ¹⁹F
- Outer No-E ¹H coil for ¹H decoupling, and an inner solenoid for the X and Y broadband channels
- The ¹H-¹⁹F channel is tunable from ¹H to ¹⁹F
- Two broadband channels with appropriate inserts
- Extended VT (XVT)
 -170 to +150°C for Wideline
 -160 to +180°C for MAS
- 1.3mm to 5 mm for Wideline
 3 mm or 4 mm for MAS





WB H/X or H-F/X MAS Probes

Wide bore ¹H/X or ¹H-¹⁹F/X (with the ¹H-¹⁹F channel tunable from ¹H to ¹⁹F)

These 2 channel probes at lower fields have a simpler design so they can be offered at lower cost. They still have the great S/N, RF field strength, and extended temperatures you have come to expect from Doty Probes.



The 4 mm 400 MHz H/X multinuclear MAS probe shown here has a single solenoid. More often, especially at higher fields, the probe would have an outer No-E coil for ¹H and a solenoid for the X channel.

- For Wide Bore Magnets
- Standard VT: -110 °C to +170 ° Extended VT (XVT): -150 °C to +250 °C
- H/X with tuning inserts ³¹P to ¹⁰³Rh
- Choice of Spinner Options 3, 4, 5, and 7 mm



¹³C-¹H (700 MHz) correlation spectrum of β -maltose monohydrate

Spectra courtesy of S. P. Brown, Univ. of Warwick, UK



WB H/X/Y or H-F/X/Y Ultra-Range MAS Probes



XC4 H/X/Y 400 MHz -100 to +260 °C

Extended VT or <u>High</u> Temperature WB Ultra-Range MAS

> The 5 mm Highest Temperature Model Features Operation Up to +500°C

Standard VT or Low Temperature . WB Ultra-Range MAS

The 3 mm Lowest Temperature Model Features Operation Down to -160°C

- For WB Magnets Only
- Broad Temperature Ranges: Standard VT: -120 °C to +170 °C. Low Temperature VT: -160 °C to +170 °C. High Temperature VT: -100 °C to +260 °C, +280 °C or to +500 °C.
- Broad Tuning Range: Triple-Tuned ¹H/X/Y with tuning inserts ³¹P to ¹⁰³Rh

Note: the ${}^{1}H/X/Y$ triple-tuned probe can be converted to double-tuned ${}^{1}H/X$ by disconnecting the third channel.

 Broad Range of Standard VT Spinner Options 3, 4, 5, or 7 mm

• Low Thermal Gradients, < 4 °C Over Sample Length

SCIENTIFIC NMR Operando Probes with 3 Axes Gradients

For Wide Bore or Narrow Bore systems.

Doty's **Operando Gradient Probes** provide a unique way to characterize battery components under reaction conditions by including a 3-axes gradient coil, for diffusion and localized spectroscopy.

Wide tuning range for nuclei of interest: ¹H/X, with ¹H and ¹⁹F on high frequency channel; Multi-X channel can include ³¹P, ⁷Li, ¹³C, ²H, and other nuclei that may be of importance.

Tunes the full range of sample loads, including hot, high molarity KOH solutions, and operating battery cells with leads coming in from above and below.

Permits order-of-magnitude better resolution (vs. solenoid) on samples where that could matter.

Variable temperature: -40 to +80 °C.

Doty's 3 axis gradient probes are suitable for NMR tubes or *in-situ* cells, **from 5 mm to 12 mm** diameter.



High Gradient Performance

- A 3 axes gradient coil system will generate X, Y and Z linear gradients for measurement of anisotropic diffusion coefficients as well as 3-axes imaging.
- •4% RMS gradient uniformity over 14 mm ϕ by 17 mm L cylinder.
- 1% duty cycle pulsed gradient of 240 G/cm with 50A at 70V.

Liquids NMR and PFG/Diffusion



Liquids Probes also with Powerful Z Gradients

- NB or WB.
- Extended Temperature (XVT) to +300 °C with sample size 5 mm
- Standard VT -40 °C to +60 °C with sample sizes
 5 mm to 20 mm
- Many tuning options: H/X/lock, H-F/X/lock, H/C/N/lock, H/F/X/lock.
- Pulsed gradient >3000 G/cm with water cooled Z-gradient.



XVT Liquids Probe with Z gradient coil H-F/X/²H Lock 300°C, 5mm NB

HR Liquids NMR Probe without gradient

Access a wide range of temperatures. Shown here is the temperature dependence of the ¹³C spectrum of Nylon 6,6 in silicone oil.





- > High magnetic fields up to 900 MHz
- Measures lowest diffusion coefficients – to 10⁻¹⁵ m²/s/
- > Optimized for minimal eddy currents
- Highest strength gradients
- Best thermal stability
- > Excellent mechanical stability
- Exceptional gradient uniformity (~1%) over a large sample volume.
- > High spectral resolution
- > ¹H/X, direct or indirect detect



Sample Temperature Ranges:

Std VT range, NB or WB: -100/+160C with water cooling Std VT range, NB or WB: -50/+80C with air cooling 5mm XVT, NB or WB, 20-40c: -140/+300C, water cooling 8mm XVT, NB or WB, 20-40c: -100/+160C, water cooling

Liquids PFG/Diffusion Z Gradient Probes



Doty 300MHZ, 16-38 Z Gradient, Diffusion Probe Results

Experimental (markers) and fitted (lines) signal attenuation as a function of diffusion gradient amplitudes and frequencies; oscillating gradient spin echo (OSGE).

Courtesy of: Junzhong Xu and Prof. John Gore, Vanderbilt University, Nashville, TN, US

Gradient Coil Parameter	Model 16-38	Model 20-40C	units	
Outside diameter	38	39	mm	
Diameter of rf shield	16	20	mm	
Clear I.D.	14	17.5	mm	
Cooling method	Water*	Water *		
Continuous gradient	341	180	G/cm	
Continuous gradient	3.4	1.8	T/m	
Pulse gradient	3320	1380	G/cm	
Duty Cycle	1.1%	1.7%		
Gradient gain, α	455	180	mT/A/m	
Continuous current	7.5	10	Α	
Peak current	73	77	Α	
<i>d</i> i for 4% local deviation	6	12	mm	
z _i for 4% local deviation	11	28	mm	
DC resistance, R _E	1.7	1.6	Ω	
Inductance, L	158	209	μH	
Slew rate, $\alpha V/L$, at 1 V	2870	860	T/m/s	
*Air cooling is possible, but results in a 50%				

*Air cooling is possible, but results in a 50% reduction in current for a given duty cycle.



Liquids NMR Probes

Liquids NMR Probes Standard, Unique, or Custom

Narrow Bore or Wide Bore

Standard VT -100°C to +160°C

5 mm to 20 mm Sample Options

¹H/X Direct or Indirect Detect

Many Tuning Options:

H/X/Lock, H-F/X/Lock

H/C/N/Lock, H/F/X/Lock

Extended Temperature (XVT) to +300°C - With 5 mm

NB or WB Perfusion Probes





HR Liquids NMR Probe

High-Temperature High-Resolution ¹³C spectrum of 30 wt % of PS2 in 1-cyclohexyl-2- pyrolidinone at 270°C. *Courtesy of B.Wade and A. S. Abhiraman, Georgia Institute of Technology and by S. Wharry and D.Sutherlin, Phillips Petroleum.*

Custom Liquids High-Resolution NMR Probes

PFG, Inverse, MRI, Quad-Tuned and more

Doty Scientific, an established leader in large-sample high-resolution (liquids) coil technology and solids NMR, is using the latest in laser cutting, compensated laminates, and thermal gradient minimization with alumina coil forms to bring its Super-B1 coils to the field of highresolution liquids NMR.

Like the 20 mm probe shown on the right, larger samples, higher temperatures, and special tuning are customary for Doty probes.

A few other distinctive probes we have provided are:

- 5 mm H/X/lock, low gamma liquids, XVT to 260 °C, 400 WB
- 5 mm H-F/X/lock diffusion, 3000 G/cm, XVT to 140 °C, 400 WB
- 15 mm H/X liquids, low ¹³C background, 600 WB



A 20 mm H/X Liquids Probe

Examp	bles of Custom Liquids High-resolution Probes
18 mm	¹ H/X liquids 600 NB, Perfusion, low ¹³ C background,
25 mm	¹ H/X 400 MHz WB, Perfusion
10 mm	¹ H/ ¹⁹ F/X/lock, 400 MHz WB, Multi-X, Triple
5 mm	¹ H/X/lock, 600 MHz NB, Inverse, 1500 G/cm PFG
15 mm	¹ H/X, 600 MHz NB, Multi-X, Microscopy, 25 G/cm continuous
5 mm	¹ H/X/lock, 1067 MHz (1.07 GHz) NB Multi-X, PFG, 77 G/cm continuous
20 mm	¹ H/X/lock, 400 MHz NB
5 mm	¹ H/X/lock, 750 MHz NB 3000 G/cm PFG



Research Results

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Results at the Advanced Imaging Research Center, Southwestern Medical Center at Dallas, Texas, USA, demonstrate the quality and versitility

of Doty liquids probes.

¹³C spectrum for a perfused heart in DOTY 25 mm ¹H/X liquids probe at 9.4 T.

The heart was perfused with hyperpolarized 2 mM [1-13C] pyruvate and natural abundance, unpolarized 2 mM octanoate. The metabolic products lactate and

unpolarized 2 mM octanoate. The 205 200 195 190 185 180 175 170 185 160 metabolic products lactate and alanine are visible after a single 66 degree detection pulse. The octanoate effectively blocks production of the bicarbonate, which would normally be about the size of the lactate. The linewidths were ~12 Hz for ¹³C on the beating heart.

Spectrum courtesy of: Dr. Matthew E. Merritt, Assistant Professor, Advanced Imaging Research Center, Southwestern Medical Center at Dallas.



High-Temperature High-Resolution ¹³C spectrum 30 wt % PPS2 in 1-cyclohexyl-2-pyrolidinone at 270°C.

Courtesy of B. Wade and A. S. Abhiraman, Georgia Institute of Technology and by S. Wharry and D. Sutherlin, Phillips Petroleum.



NB 1067MHz 1H/X (with 2H Lock) PFG Diffusion Probe

Spectra Courtesy of Dr Warren Warren (Princeton) and NHMFL, Florida





Ultra Low Temperature

Ultra Low Temperature (ULT) Probes

ULT probes, with or without DNP

Revolutionary, Affordable, Routine

Works with standard liquid helium recycling systems

High-efficiency H/X or H/X/Y RF up to 1200 MHz

High-efficiency Microwave Cavity

No special cryo-cooling system required !

Requires only RT bearing and drive gas inputs, He or N₂

Single low-pressure coolant line from standard liquid He or N₂ cryostat

Exhaust helium (coolant and spin gas) compatible with standard He recycling systems

Rapid cool-down and warm up (~30 minutes) Heat Exchanger in the Vacuum Base of the ULT Probe



Acknowledgement: NIGMS R43GM148111







DTY Wideline NMR Probes

Some Wideline NMR Probe Options:

- 3 mm, 4 mm, 5 mm, 7 mm, 8 mm, or 10 mm (WB only) sample
- Wide Bore or Narrow Bore probes
- Temperature ranges for Narrow Bore Probes -80°C to 120°C, Standard VT for NB -160°C to 200°C, XVT for NB
- Temperature ranges for Wide Bore Probes
 -110°C to 150°C standard VT for WB
 -170°C to 250°C, XVT for WB
- H/X, Double resonance with multinuclear observe
- H/X/Y, Triple resonance with multinuclear observes
- A low cost ²H-only option is available, which can be tuned for use at more than one field strength

A probe is delivered with ten sample containers and 20 plugs.

The wide range of available options listed above offers exceptional versatility, usually all you'll need.

However we also offer unique probes – such as *the wideline 3 mm narrow bore H/X probe with a temperature range to 250 °C and impressively low ¹H background signals*, shown on the following page.





The times above indicate relaxation delay. The probe is tunable to ²H at 400, 500, or 600 MHz ¹H freq. Courtesy of Michael Frey, JEOL USA

SCIENTIFIC Southed Angle Spinning (SAS) NMR Probes

The ¹H/X/Y probe has a ¹H channel and two broadband channels X and Y.

The 500 MHz probe was tuned to $^{1}H/^{13}C/^{15}N$.

The 4 mm sample was spinning 15.9 KHz.

Flipping precisely from 90° to Magic Angle in 15 ms.





Magic Angle Gradient MAG MAS Probes



... For gradient spectroscopy and diffusion.

Ultra-high gradients 400 G/cm PFG at 14 T Exceptional recovery High resolution Wide VT range H/X/Y/lock NB or WB Probes



500 MHz, H/X 4 mm NB MAS Probe with Magic Angle Gradients

solids (powder) viscous liquids semi-solids H DIPSI-2 water 20 Diffusion constant (10⁻⁹ m^2/s) ASAP-HMQC 50.0 DOS RFDR DEC 1H CP 8 100.0 <ntr} 150 150.0 (mdd) D¹³C (mdd) 130 ¹H (ppm) 10 ¹³C (ppm) 150 100 50 ¹H (ppm) 5.0 0

MAS NMR data:

- A) Radio frequency driven rotational resonance (RFDR) ¹³C/¹³C correlation spectrum of uniform ¹³C, ¹⁵N-Leucine powder, *4 scans*;
- B) Inverse ¹H detected heteronuclear multiple quantum correalation spectrum of 4-cyano 4'-biphenyl nematic liquid crystals in natural abundance, *2 scans*;
- C) Single-scan diffusion-ordered 2D spectra of 4-cyano 4'-biphenyl in chloroform and water.



PGSE decay curve with diffusion time of 30 ms. The self-diffusion coefficient for F⁻ at 40°C in polymeric fluoride ion conductor was measured to be in the 2x10⁻¹⁰ - 4x10⁻¹⁰ m²s⁻¹ range depending on the type of material.

3

 $(\gamma g \delta)^2 (\Delta - \delta/4 - \tau/2) [x 10^{10} sm^{-2}]$

4

5

2

0

Doty Scientific would like to thank Dr. F. Ziarelli and Prof. Dr. S. Viel, Aix-Marseille Université. Pasquini et al., ChemPhysChem. 2015, 17, 363.



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Two-dimensional ¹H detected homonuclear correlation spectrum of Glycine powder. 300 MHz ¹H spectrum was recorded under 7 kHz MAS and wPMLG3 acquisition.



Bench Spinner Assemblies

Bench spinners enable researchers to spin-pack samples and test sample balance on the bench. Some stators in bench spinner assemblies have thicker walls for added durability.



Bench Spinners *

# 95701	3 mm DI	\$14,128
# 95723	4 mm DI	. 13,560
# 95719	4 mm XC	13,560
# 95720	5 mm XC	. 13,560
# 95715	7 mm XC	. 13,560

A spin rate preamp and cable (shown above) is supplied with the bench spinner and included in the price. **A 40%** *discount will be given on a bench spinner ordered on the same purchase order with a corresponding probe.*

Spin Rate Detection and Regulation

# 99560	Spin Rate Detection Preamp / Power Supply 115 V		
# 99455	Spin Rate Detection Preamp / Power Supply 230 V		\$3270
# 98930	Spin Rate Detection Preamp Cable for Optics	5	\$106
# 98931	Spin Rate Detection Preamp Cable for Tribo	0	\$106
# 69300	Digital Frequency Counter		\$683
# 91581	Filtered Dual Air Regulator		\$3,327



Temperature Control Accessories

Doty probes have variable temperature capabilities, and the widest range of extended temperature options.

To extend the temperature range, we add extra insulation and thermal baffles, utilize special materials, add additional room air, and in some cases, add extra dewars to the probe.

For Probes with Extended Temperatures above 160°C and below -100°C the hot or cold gases must be exhausted away from the magnet. With some probes including the wide bore triple-tuned *H/X/Y* Ultra-range **MAS probes** (high temperature or low temperature), cryogenic probes, PFG probes, Liquids Probes, and a few other special probes the VT gas is exhausted with a tube out the base of the probe. In most Narrow Bore, and Wide Bore double-tuned H/X MAS probes, a Probe Exhaust Dewar (listed below) will exhaust the VT gas out the top off the probe.

Probe Exhaust Dewar

In **most** Narrow Bore MAS probes and Wide Bore double-tuned H/X MAS probes, a Probe Exhaust Dewar is required for sample temperatures above 160°C and below -100°C. The exhaust dewar is included in extended VT probe options but may be ordered separately. Please supply the probe serial number when ordering to ensure the proper dewar is supplied. **# 95980** Probe Exhaust Dewar \$ 1010

50-Liter Liquid Nitrogen Dewar

This dewar is intended to be used with the Doty Cold-Gas System. (A Nitrogen Dewar already owned or purchased locally may be used if compatible with the coldgas system, however specifications must match.)

86020 50-Liter Liquid Nitrogen Dewar \$2140

Cold-Gas Supply Systems

Doty cold gas supplies include a heat exchanger with one, two or three intertwined pre-cooling coils; appropriate cooling coil sets; and one, two or three transfer lines to carry the cooled gas to the probe.

(The pre-cooler counterflow heat exchanger in the neck of the storage dewar greatly improves cooling efficiency – an important consideration for extended runs.)

The heat exchanger connects to the Doty probe with flexible, foam-insulated transfer lines with fully dewared quick connects. This system provides efficient cold gas supply for temperatures down to -150°C. The cold gas supply shown below is connected to a probe at one end and connected to a flow meter and regulated gas supply on the other. This system is designed to be used with the **standard 50-liter nitrogen dewar** and **probe exhaust dewar**, (listed in the left column) both of which **must be ordered separately.**

99860 Single-Supply Cold-Gas System ... \$4,040

This cold-gas supply is for, standard speed or wideline probes and other single-supply applications. Also for OptiMAS[™] cold zone cooling when VT gas is supplied by a separate system.

95970 Dual-Supply Cold-Gas System \$5,940

For spinning with separate bearing and drive or for other dual-supply applications. (Includes two intertwined precooling coils, two cooling coil sets, and two transfer lines.)







DOTY General Accessories (Air Connectors, Paints, Glues)

Item			Part #	Price US\$
#96383-XVT This XVT version is used for low temperature experiments			\$ 140	
# 96383 Brass Snap Tite Probe A nector with male quick c	ir Con- ionnect	 without a Doty cold gas VT system. Please supply the DotySerial number "DSI" when ordering. 		(XVT) \$ 165
Filtered Air Line with Female Quick Connect These airlines are used for room temperature air cooling and other non-MAS probe air requirements.			# 96382	\$ 82
	# 96382			
Filtered Air L These MAS air lines have in at the drive and bearing inl	ine with Female Quick Conne nternal channels that reduce ets on MAS probes. # 96382-MAS	ect – For MAS turbulance	# 96382-MAS	\$ 121
Filtered Air Line with Male Quick Connect			# 90617	\$ 82
Quick Connect Set	Female Quick Connect	Male Quick Connect	# 96390	\$ 66
	Comments of the second		# 58560	\$ 33
# 96390	# 58560	# 58550	# 58550	\$ 33
Ball and Clamp Probe Air Connector to male connect (Used on Early Probes)				
			# 96381	\$ 82
	Optical <u>Rotor</u> Paints		# 96109	\$ 95
	Glue for Caps for XVT		# 99529	\$ 66

(US\$ – Foreign prices higher, plus taxes.)



We have new, more robust turbines for DI-3 and DI-4 rotors. We are phasing these in beginning with Torlon and GFT. The new design includes modified turbine blades and a threaded hole with a different thread pitch thus necessitating a new Insertion and Removal Tool with matching thread. (New spacers will have the new thread as well.) We will continue to supply which-ever turbine puller you need (or both).

Item	Turbine and Spacer Insertion and Removal Tool	Thread
DI-3 Turbines		Part No: 06027 0-80 THREAD
Note how the turbine blades are connected to form a ring around the threaded hole. New DI-3 Turbine		Part No: 03516 M1.2 – 25 THREAD

Accessories For 3mm DI (Drop-in) Spinners

Teflon spacers are for highest homogeneity and rf field strength.
For material specifications: http://dotynmr.com/download/Materials-and-Speeds-Data.pdf

DI-3 Ro Low d Thick W	otor Lei ensity* : /all Roto	ngth =17.8 mm Spinning max r – Max. 28 kHz	DI-3 Samp Without spac <i>With space</i>	le Volume: ers = 36.5 μl rs = 13.6 μl	Front DI Turb	ine	Rear DI Tip Cap
Please	Please note: Although the front turbine and rear tip cap are sold separatel a front turbine and a rear tip cap, are needed for spinni					y, a pa ng.	air consisting of
Part #	Price		Descript	ion		Maxi	mum Spin Speed*
			3 mm Rote	ors and Caps			
46082	\$690	3 mm rotor – Silico	on Nitride				26 kHz
46082- P	765	3 mm Rotor – Silic For DI probes or	con Nitride - Paint Bench Spinners	ed with optical dete	ction		26 kHz
3 mm DI Turbines and 3 mm Tip Caps							
46083	\$80	DI 3 front turbine of	DI 3 front turbine cap – <i>GFT</i> (glass filled torlon)			26 kHz	
46084	80	3 mm Rear Tip Cap – <i>GFT</i> (glass filled torlon)			28 kHz		
46252	80	DI 3 front turbine cap – Torlon (can use with <i>GFT</i> Tip)			26 kHz		
46072	80	3 mm Rear Tip Cap – Torlon		26 kHz			
46077	80	DI3 front turbine cap – Aurum 18 kHz		18 kHz			
46076	80	3 mm Rear Tip Ca	p – Aurum				18 kHz
46075	80	DI 3 mm front turk	oine cap – Kel-F				11 kHz
46074	80	3 mm Rear Tip Ca	p – Kel-F				11 kHz
46179	28	DI 3 mm Teflon S	pacer	Restricts/centers	s the sample to	within t	he coil region. Two
46168	28	DI 3 mm Kel-F Sp	bacer	are required.			
Part #	Price	Сар	Pullers and A	ccessories			
06027 or 03516	\$80	DI3 Turbine or Spacer Insertion and Removal Tool					
96195	125	Rotor Holder and Plungers – tools for tip cap and rear spacer removal					
96501	96501 185 Sample Packing Set for 3 mm Rotors						



Accessories For 4 mm DI (Drop-in) Spinners

We have new, more robust turbines for DI-3 and DI-4 rotors. We are phasing these in beginning with Torlon and GFT. The new design includes modified turbine blades and a threaded hole with a different thread pitch thus necessitating a new Insertion and Removal Tool with matching thread. (New spacers will have the new thread as well.) We will continue to supply which-ever turbine puller you need (or both).

Item	Turbine and Spacer Insertion and Removal Tool	Thread
DI-4 Turbines		Part No: 01003 1-72 THREAD
Note how the turbine blades are connected to form a ring around the threaded hole. New DI-4 Turbine		Part No: 06027 0-80 THREAD

> Thick wall rotors and Torlon caps are provided for **fastest spinning.** DI4 Thin wall rotors and caps are available for maximum signal to noise. The maximum speed of thin wall rotors is about 50% the maximum speed of thick wall rotors. Teflon, Kel-F or PPS spacers are provided for highest homogeneity and rf field strength.

For material specifications: http://dotynmr.com/download/Materials-and-Speeds-Data.pdf

<u>4 mm</u> DI-4	DI4Sample Volume :	Front	Rear
Rotor Length =24.95 mm		DI Turbine	DI Tip Cap
Low density* Spinning max Thick Wall rotor – Max. 18 kHz	Thick Wall = 122 μ l, with Spacers = 60 μ l Thin Wall = 158 μ l, with Spacers = 77 μ l		Ļ

Please note: Although the front turbine and rear tip cap are sold separately, a pair consisting of a front turbine and a rear tip cap are needed for spinning.

DI4 #	Price	Description		Maximum SpinSpeed*
		Thick Wall Rotors and Caps		4 mm
45127	\$712	DI 4mm Thick Wall Rotor – Silicon Nitride		18 kHz
45127-P	790	DI 4mm Thick Wall Rotor – Silicon Nitride - Painted	*	18 kHz
45129	\$82	${ m DI}$ 4mm Front Turbine Cap for Thick Wall – GFT (g	lass filled torlon)	18 kHz
46136	82	DI 4mm Rear Tip Cap for Thick Wall – GFT (glass f	illed torlon)	18 kHz
46142	82	DI 4mm Front Turbine Cap for Thick Wall – Torlon		18 kHz
46140	82	DI 4mm Rear Tip Cap for Thick Wall – Torlon		18 kHz
46142-A	82	DI 4mm Front Turbine Cap for Thick Wall – Aurum		15 kHz
46140-A	82	DI 4mm Rear Tip Cap for Thick Wall – Aurum		15 kHz
45130	82	DI 4mm Front Turbine Cap for Thick Wall – Kel-F		9 kHz
46137	82	DI 4mm Rear Tip Cap for Thick Wall – Kel-F		9 kHz
45137	30	DI 4mm Spacer for Thick Wall Rotors – Teflon		
46206	30	D 4mm Spacer for Thick Wall Rotors – Kel-F	Restricts/centers the sample to within	
46401	30	D 4mm Spacer for Thick Wall Rotors – PPS	con region. Two	are required.

* Painted rotors are for probes with optical detection



Accessories For 4 mm DI (Drop-in) Spinners

DI4 #	Price	DI4 Thin Wall Rotors and Cap)S	Maximum Spin Speed	
03136	\$712	DI 4mm Thin Wall Rotor – Silicon Nitride		12 kHz	
03136-P	790	DI 4mm Thin Wall Rotor – Silicon Nitride - Pair Painted rotors are for probes with optical detect	ion	12 kHz	
45128	648	DI 4mm Thin Wall Rotor – Zirconia (Use Only With Probe with Optical detection)		10 kHz	
45131	82	${\rm DI}$ 4mm Front Turbine Cap for Thin Wall – GFT (gla	ass filled torlon)	12 kHz	
46138	82	$\mathrm{DI}4\mathrm{mm}\mathrm{Rear}\mathrm{Tip}\mathrm{Cap}$ for Thin Wall – \mathbf{GFT} (glass fil	led torlon)	12 kHz	
46141	82	DI 4mm Front Turbine Cap for Thin Wall – Torlon 12 kHz			
46169	82	DI 4mm Rear Tip Cap for Thin Wall – Torlon 12 kHz			
46141-A	82	DI 4mm Front Turbine Cap for Thin Wall – Aurum 12 kHz			
46169-A	82	$DI4mm$ Rear Tip Cap for Thin Wall – ${\rm Aurum}$	DI 4mm Rear Tip Cap for Thin Wall – Aurum 12 kHz		
45132	82	$DI4mm$ Front Turbine Cap for Thin Wall – $\mbox{Kel-F}$		9 kHz	
46139	82	DI4mm Rear Tip Cap for Thin Wall – Kel-F		9 kHz	
45138	30	DI 4mm Spacer for Thin Wall Rotors – Teflon	De etuiete (e e ute ue		
46207	30	DI 4mm Spacer for Thin Wall Rotors – Kel-F	coil region) Two	are required.	
46402	30	DI 4mm Spacer for Thin Wall Rotors – PPS	conregion). The	are required.	
DI4 #	Price	Cap Pullers and Accessories			
01003 or	¢87	DI4 Turbine or Spacer Insertion and Removal Tool	I		
06027	φυΖ	(Used for both turbine caps and spacers - since 10/2012)			
96188	130	Rotor Holder and Plungers – tools for tip cap and re	ear spacer removal		
99683	190	Sample Packing Set For Thick Wall DI 4 Rotors			
99682	190	Sample Packing Set For Thin Wall DI 4 Rotors			



DI-4 Sealing Cells for Liquids and Semi-Solids

Sealing cells are for use inside DI thin-walled ceramic rotors. The plastic cells are available in Kel-F with teflon plugs for proton NMR, or in ultem with polyvinyl-chloride (PVC) plugs for fluorine NMR.

All cells are suitable for long-term sample storage without loss. They may be used with all common solvents, including acetone, alcohols, benzene, DMSO, ethers, methylene chloride, strong bases, and most strong acids – as long as the sample density does not exceed the density of the plug (2.2 g/cm³ for teflon, 1.4 g/cm³ for PVC).





Sealing Cells for Liquids and Semi-Solids For XC and DI Spinners

All sealing cells are for use inside XC and DI thin-walled ceramic rotors. The plastic cells are available in Kel-F with teflon plugs for proton NMR or in ultern with polyvinyl-chloride (PVC) plugs for fluorine NMR.

All cells are suitable for long-term sample storage without loss. They may be used with all common solvents. including acetone, alcohols, benzene, DMSO, ethers, methylene chloride, strong bases, and most strong acids - as long as the sample density does not exceed the density of the plug (2.2 g/cm³ for teflon, 1.4 g/cm³ for PVC).

For material specifications: http://dotynmr.com/download/Materials-and-Speeds-Data.pdf



XC4 and XC5



<u>4 mm</u> 2	<u>XC4</u> Sea	ling Cells	s. (For thin	n wall rotors)	<u>5 m</u>	m <u>XC5</u>	Sealing Co	ells. (For t	t hin wall roto	r s)
Kel-F cells	s with te	eflon plug	s or Ultem	cells with PVC	Kel	-F cells	with teflon	plugs or Ul	tem cells with	PVC
plugs. <u>Use</u>	e with thi	n-walled	rotors and s	short XC caps.	plue	gs. <u>Use</u>	with thin-w	valled roto	rs and short)	<u>XC caps.</u>
	Kel-F <u>Part #</u>	Ultem <u>Part #</u>	Sample <u>Volume</u>	Price			Kel-F <u>Part #</u>	Ultem <u>Part #</u>	Sample <u>Volume</u>	Price
XC4	99694	99691	40 μL…	\$52		XC5	99801	99793	75 μL	\$52
XC4	99693	99689	20 μL …	52		XC5	99799	99792	50 μL	52

Note: XC rotors use a front turbine cap and rear turbine cap.

23

Price



Rotors for XC and SuperSonic (SS) MAS Spinners

XC Rotors

	<u>4 mm XC4 Length =20.95 mm</u>				
	Sample – 66 μ L to 124 μ L				
Lo	Low density* Spinning maximum kHz				
# 43255	# 43255 Silicon Nitride XC Thick Wall Rotor 22 \$654				
# 43483	Zirconia XC Thin Wall Rotor	11	654		

<u>5 mm XC5 Length =22,25 mm</u>					
	Sample – 82 μL to 201 μL				
Lo	Low density* Spinning maximum kHz				
# 13265	Silicon Nitride XC Thick Wall Rotor	18	\$654		
# 13267	Silicon Nitride XC Thin Wall Rotor	16	660		
# 13268	Zirconia XC Thin Wall Rotor	9	654		

	<u>7 mm XC7 Length =29.00 mm</u>				
	Sample – 241 μ L to 564 μ L				
Lo	Low density* Spinning maximum kHz				
# 43526	Silicon Nitride XC Thick Wall Rotor	12	\$654		
# 43528	Zirconia XC Thick Wall Rotor	8	495		
# 43527	Silicon Nitride XC Thin Wall Rotor	11	715		
# 43529	Zirconia XC Thin Wall Rotor	7	550		

10 mm XC10 Length =35.00 mm Sample volume – .6 mL to 1.10 mL Low density* Spinning maximum | kHz |

# 44200	ZITCOMIA AC THICK WAII ROLOF	0.0	\$012
# 44266	Zirconia XC Thin Wall Rotor	4.5	918



SuperSonic Rotors

5 mm SuperSonic (SS) Length =14.93 mm						
	Sample volume – 56 μL to 110 μL					
Lo	Low density* Spinning maximum kHz					
# 13251	Silicon Nitride SS Thick Wall Rotor	18	\$654			
# 42388	Silicon Nitride SS Thin Wall Rotor	16	660			
# 42396	Zirconia SS Thin Wall Rotor	9	654			

7 mm SuperSonic (SS) Length =22.10 mm					
	Sample volume – 215 μL to 360 μL				
Lo	Low density* Spinning maximum kHz				
# 13857	Silicon Nitride SS Thick Wall Rotor	12	\$605		
# 13858	Zirconia SS Thick Wall Rotor	8	495		
# 13859	Silicon Nitride SS Thin Wall Rotor	11	715		
# 13861	Zirconia SS Thin Wall Rotor	7	550		

10 mm SuperSonic (SS) Length =27.50 mm					
	Sample volume – .6 mL to 1.10 mL				
Low density* Spinning maximum kHz					
# 42113	Silicon Nitride SS Thick Wall Rotor	8.5	\$ 864		
# 42138	Zirconia SS Thick Wall Rotor	6	864		
# 42193	Silicon Nitride SS Thin Wall Rotor	8	918		
# 42173	Zirconia SS Thin Wall Rotor	4.5	918		

> For material specifications: <u>http://dotynmr.com/download/Materials-and-Speeds-Data.pdf</u>

- Thick wall rotors and GFT or Torlon caps are provided for fastest spinning and ease in packing. Thin wall rotors and caps are available for maximum signal to noise. The maximum speed of thin wall rotors is about 50% the speed of thick wall rotors. Long caps are provided for highest homogeneity and rf field strength.
- For XC probes, (beginning in 2000) XC "Slow MAS" is provided for stable very slow spinning of tissues, liquids, and CC by a change in "nozzle caps" only. The same turbine caps are used. All choices of XC rotors and caps may be used with slow spin nozzle caps. A 50% reduction in maximum spinning speeds should be expected for each type. See page 4 for more specifications.

XC, SuperSonic, DI, High Speed, and Standard accessories are <u>not</u> interchangeable <u>unless specified</u>. <u>If unsure about</u> <u>correct supplies, contact us with the probe DSI-serial number and we can help.</u>



Accessories for XC

SuperSonic (SS) and XC rotors and caps are different. Check the rotor length to be sure you order the correct parts.

For material specifications: http://dotynmr.com/download/Materials-and-Speeds-Data.pdf

XC4	XC5	XC7	Remains the definition for large the former life of the second second second second second second second second	
4 mm Rotor Length = 20.95	5 mm Rotor Length = 22.25	7 mm Rotor Length = 29.00	to confirm that you need XC parts	on the left
Part #	Part #	Part #	Description	Price
	C	aps for THICK V	Vall Rotors – fastest spinning	
99705	96432	96462	XC Kel-F Short Thick Cap Pair	\$184
99702	99844	99637	XC Kel-F Long Thick Cap Pair	184
99684	99822	99816	XC GFT Short Thick Cap Pair, GFT (glass filled torlon) 210
99685	99821		XC GFT Long Thick Cap Pair, GFT (glass filled torlon) 210
96431	96457	96466	XC Torlon (or Aurum *) Short Thick Cap Pair	210
96433	99839		XC Torlon (or Aurum *) Long Thick Cap Pair	210
		96468	XC/SS Kel-F O-Ring Cap Pair	298
		96469	XC/SS Aurum O-Ring Cap Pair	298
Caps for THIN Wall Rotors				
99699	96434	96464	XC Kel-F Short Thin Cap Pair	
99697	99835	99635	XC Kel-F Long Thin Cap Pair	
99686	99824	99817	XC GFT Short Thin Cap Pair, GFT (glass filled torlon)	
99687	99823		XC GFT Long Thin Cap Pair, GFT (glass filled torlon) 2	
99722	99834	96465	XC Torlon (or Aurum *) Short Thin Cap Pair	
99723	99833	99636	XC Torlon (or Aurum *) Long Thin Cap Pair	210
		Cap Pull	ers and Accessories	
96182	96182	96360	Puller for Turbine Caps	\$248
		96170	Threaded Cap Puller for O-ring Caps	130
01026	06019	06023	Rotor Holder – use with plungers below	52
01028	06021	43761	Plunger - thick wall- to push out caps or sealing cells	42
01029	06022	42039	Plunger - thin wall- to push out caps or sealing cells	42
99683	96511	96113	XC Sample Packing Set for Thick Wall Rotors	\$190
99682	96513	96114	XC Sample Packing Set for Thin Wall Rotors	190
		MAS Turbine	Cap Spinning Speeds	
	Maximum	Spinning Speed	s (kHz) For Caps at Room Temperature	
Cap Styl	e	4 mm XC	5-mm XC 7-mm	хс
Kel-F		11	10 7	
Caps with o-	rings		7	
Aurum	_	22	18 12	
Torlon or GF	T	22		
This chart represents <u>only</u> material characteristics for caps. Check the <u>Probe</u> and Rotor Specifications.				

* Torlon has very similar NMR properties and will be substituted if Aurum is not available.



Accessories Supersonic (SS)

SuperSonic (SS) and XC rotors and caps are different. Check the rotor length to be sure you order the correct parts.



For material specifications: <u>http://dotynmr.com/download/Materials-and-Speeds-Data.pdf</u>

SS 5 mm	SS 7 mm	If unsure, check the rotor length (mm) listed on the left			
5 mm Rotor Length = 14.93 mm	7 mm Rotor Length = 22.10 mm	to confirm that you need SS parts.			
Part #	Part #	Description	Price		
	Caps for	r THICK Wall Rotors – fastest spinning			
96432-SS	96462	SS Kel-F Short Thick Cap Pair	\$184		
99822-SS	99816	SS GFT Short Thick Cap Pair, GFT (glass filled torlon)	210		
96457-SS	96466	SS Torlon (or Aurum*) Short Thick Cap Pair	210		
	96468	SS Kel-F O-Ring Cap Pair	298		
	96469	SS Aurum O-Ring Cap Pair	298		
Caps for THIN Wall Rotors					
96434-SS	96464	SS Kel-F Short Thin Cap Pair	\$184		
99824-SS	99817	SS GFT Short Thin Cap Pair, GFT (glass filled torlon)	210		
99834-SS	96465	SS Torlon (or Aurum*) Short Thin Cap Pair	210		
96472-SS	90613	SS Torlon Long Thin Cap Pair	210		
		Cap Pullers and Accessories			
96182	96360	Puller for Turbine Caps	\$248		
	96170	Threaded Cap Puller for O-ring Caps	130		
06019	06023	Rotor Holder – use with plungers below	52		
06021	43761	Plunger - thick wall- to push out caps or sealing cells	42		
06022	42039	Plunger - thin wall- to push out caps or sealing cells	42		
96059	96510	SS Sample Packing Set for Thick Wall Rotors	190		
96515	96517	SS Sample Packing Set for Thin Wall Rotors	190		
MAS Turbine Cap Spinning Speeds					

Maximum Spinning Speeds (kHz) For Caps at Room Temperature

Cap Style	5-mm SuperSonic	7-mm SuperSonic			
Kel-F	10	7			
Caps with o-rings		7			
Aurum	18	12			
Torlon or GFT 18 12					
This chart represents <u>only</u> material characteristics for caps.					
Check the Probe and Rotor Specifications.					

* Torlon has very similar NMR properties and will be substituted if Aurum is not available.

DOTY SCIENTIFIC Accessories for 5 mm and 7 mm High-Speed MAS

For material specifications: http://dotynmr.com/download/Materials-and-Speeds-Data.pdf

5 mm High Speed

Rotor length= 14 93 mm

Thick wall rotors are provided for fastest spinning and ease in packing. Thin wall rotors and short caps provide maximum signal to noise. Long caps are provided for highest homogeneity and rf field strength or for limited samples.

High Speed, SuperSonic, XC, DI, and Standard accessories are <u>not</u> interchangeable unless specified. <u>If unsure about correct supplies, contact us with the probe DSI-serial number and we can help.</u> Note: SuperSonic rotors may be used in High Speed spinners, but High Speed rotors will not work in SuperSonic spinners.

Turbine Cap Design

Spinning speed max. 14 kHz,		L OB	SON .	Spinning s	peed max	. 9 kHz,	
Sample	volume –	· 57 μL to 95 μL	FRONT CAP	REAR CAP	Sample volume –	240 μL to	370 μL
Part #	Price		Descr	iption		Part #	Price
		Thick Wall Rotors					
13260	\$ 605	Silicon Nitrio	le Rotor			13860	\$ 605
13280	275	Macor Roto	ſ			13880	275
		End Caps for Thick	<u>Wall</u> Zirconia a	and Silicon Nitric	le Rotors		
97780	\$120	Kel-F Short	Cap Pair			97830	\$120
97810	120	Kel-F Long	Cap Pair			97860	120
97790	132	Aurum (or 7	orlon*) Short Ca	ıp Pair		97840	132
97820	132	Aurum Long	l Cap Pair			97870	132
96446	230	Kel-F O-Rin	g Cap Pair**			96447	230
96900	230	Aurum O-Ri	ng Cap Pair**			96448	230
		End Caps for Maco	<u>r</u> Rotors				
13291	\$116	Kel-F O-Ring Rear Turbine for Macor Rotor** 13531					\$116
13680	116	Aurum O-Ring Rear Turbine for Macor Rotor** 13533 11					
		Thin Wall Rotors					
42384	\$715	Silicon Nitride Rotor					\$715
42238	605	Zirconia Rot	or			42237	605
		End Caps for Thin V	<u>Vall</u> Zirconia ar	nd Silicon Nitride	Rotors		
96485	\$120	Kel-F Short	Cap Pair			96481	\$120
96486	120	Kel-F Long	Cap Pair			96482	120
96487	132	Aurum Shor	t Cap Pair			96483	132
96488	132	Aurum Long	Cap Pair			96484	132
		Cap Pullers and Ac	cessories				
94810	\$253	Kel-F Front	Housing Cap			94790	\$253
94820	341	Kel-F Back	Housing Cap			94800	341
7130	33	Kel-F Housi	ng Thumb Screws	s (priced per pair)		7130	33
96360	192	Puller for Lo	ng and Short Kel-	-F, Vespel, Torlon c	r Aurum Caps	96310	192
96190	120	(5 mm) Blac	k Threaded End-	Cap Puller for O-rin	g Caps (4-48 Thread)		
		(7 mm) Gra	/ Threaded End-C	Cap Puller for O-ring	g Caps (6-40 Thread)	96180	120
96530	176	Sample Pac	king Tool Set for	Thick Wall		96540	176
96514	176	Sample Packing Tool Set for Thin Wall 96516 17					

* Torlon has very similar NMR properties and may be substituted if Aurum is not available.

** <u>Specify on the order</u>. – One can insert o-ring turbines by twisting them in by hand. Or, O-ring turbine caps can be ordered with threaded holes for insertion and removal with a threaded cap puller. Front turbine caps can also be ordered with an axial out-gassing hole for high temp work or to remove air bubbles. *O-ring caps can be used for liquids, for sealing, or for VT.*

7 mm High Speed

Rotor length= 22 10 mm

(US\$ – Foreign prices higher, plus taxes.)



Accessories For 5 mm and 7 mm Standard MAS

Short caps are provided for maximum signal to noise. Long caps are provided for highest homogeneity and rf field strength. Long caps are also for limited samples.

For material specifications: http://dotynmr.com/download/Materials-and-Speeds-Data.pdf

Standard, High Speed, SuperSonic, XC, and DI and accessories are <u>not</u> interchangeable. If unsure about correct supplies, contact us with the probe DSI-serial number and we can help.

<u>5 mm Standard</u>

Rotor length=13.08 mm

Turbine Cap Design



Spinning speed max. 9 kHz,



Rotor length=18.31 mm Spinning speed max. 6 kHz, Sample volume – 200 μL to 350 μL

Sample volume – 60 μ L to 110 μ L

Part #	Price	Description	Part #	Price		
	1					
5511	\$660	Silicon Nitride Rotor	7511	\$660		
5520	362	Zirconia Rotor	7520	362		
5900	275	Macor Rotor	7900	275		
		End Caps for Zirconia and Silicon Nitride Rotors				
97650	\$88	Kel-F Short Cap Pair	97500	\$88		
97660	88	Kel-F Long Cap Pair	97510	88		
96518	55	Kel-F Spherical Sample Cell Insert Pair for CRAMPS Experiments (Use with long Kel-F caps)				
97680	100	Aurum Short Cap Pair	97530	100		
97690	100	Aurum Long Cap Pair	97540	100		
96443	170	Kel-F O-Ring Cap Pair*	96435	170		
97940	170	Aurum O-Ring Cap Pair*	96445	170		
End Caps for Macor Rotors						
5980	\$50	Kel-F Plug Cap for Macor Rotor				
5990	50	Teflon Plug Cap for Macor Rotor				
5572	116	Kel-F O-Ring Plug Cap for Macor Rotor*	7541	\$116		
5573	116	Aurum O-Ring Plug Cap for Macor Rotor*	7542	116		
		Cap Pullers and Accessories	1			
5170	\$170	Kel-F Front Housing Cap	7170	\$170		
7130	33	Kel-F Housing Thumb Screws (priced per pair)	7130	33		
96220	192	Puller for Long and Short Kel-F, Vespel, Torlon or Aurum Caps	96240	192		
96170	120	5 mm Blue Threaded End Cap Puller for 5 mm O-ring Caps (24 mm Thread)				
		7 mm Red Threaded End-Cap Puller for 7 mm O-ring Caps, (5-44 Thread)	96250	120		
		For 7 mm Macor caps for Macor rotors - Black Threaded Cap Puller (4-48 Thread)	96190	120		
96500	176	Sample Packing Tool Set for Silicon Nitride and Zirconia Rotors	96520	176		
4710	55	Packing Tamp for Caps with Axial Screws	4700	55		

* <u>Specify on the order</u>. – Some prefer to insert o-ring turbines by twisting them in by hand. However, o-ring turbine caps can be ordered <u>with threaded holes</u> to be inserted and removed with the threaded cap puller. (Plug caps must be removed with the threaded tool.) Front turbine caps can also be ordered <u>with an axial out-gassing hole</u> for higher temperature work or to remove air bubbles. *O-ring caps can be used for liquids, for sealing, or for some VT.*



Doty Spinner Assembly Materials

Doty spinners utilize super-precision, wear-resistant ceramic stators of silicon nitride or zirconia. MAS spinner materials must be chosen carefully based on background signals and temperature ranges. Ceramic rotors and plastic caps of various materials are available to provide fast spinning with limited background problems.

		Material Specifi	cations	Turbine Cap Specifications		
Material	Upper Temp	Major Constituents	Minor Elements	Recommended Use	Cap VT Operation Range	
Silicon Nitride	1400°C *	98% Si ₃ N ₄	2% Y ₂ O ₃ , .005 Al			
Zirconia	650°C *	94 ZrO ₂ , 4 Y ₂ O ₃	Hf, 0.3% Si, .02 Al			
Macor	650°C *	Al, Si, O, B, K	2% F, Mg			
Kel-F	130°C *	F, C, Cl		proton & carbon studies	-20°C to 70°C.	
GF Torlon (30% Glass)	260°C*	H, C, O, Si	Ti, N, F	fast spinning, wide temperature range, wear resistant	-120°C to 160°C (glued in with epoxy -170°C to 250°C)	
Glass Fibers in GFT		SiO ₂	CaO, MgO, Al ₂ O _{3,} B ₂ O ₃ ,			
Torlon	260°C*	Н, С, О	Ti, N	fast spinning and low ²⁹ Si or low ¹⁹ F	-30°C to 80°C	
Aurum	240°C *	Н, С, О	Ν	fast spinning and low ²⁹ Si or low ¹⁹ F	-30°C to 80°C	
Vespel	300°C *	Н, С, О	N	special extended VT caps	-270°C to 240°C	

* Note: This chart represents <u>only</u> material characteristics. Check the Probe Specifications. Non-spinning parts can tolerate different temperatures than turbine caps spinning on rotors.

Spinner Assembly Materials – Plastics

GFT (Glass-fiber-reinforced Torlon): Glass-fiber-reinforced Torlon grade 5030 will be used for some MAS turbine caps for greatly improved VT performance and all-around better reliability and performance. This new material stands out from the rest with respect to isotropic thermal expansion (only 16E-6/°C), tensile strength at 200°C (120 MPa), and heat distortion temperature (282°C). It also has rather low moisture absorption, high wear resistance, and high impact strength. These caps are the most wear resistant and have the widest temperature range. GFT is not recommended for proton studies, or for some silicon and some carbon studies. Caps may be used from -120°C to 160°C repeatedly (or when glued in with epoxy from -170°C to 250°C).

Torion: Torion is used for fastest spinning of DI3 turbines. This green thermoplastic polyamide-imide, has exceptional chemical resistance. Caps may be used from -30°C to 80°C repeatedly. *The caps may be used once to higher temperatures but they will be too loose after that.* (In non-spinning parts of the spinner assembly, the upper temperature limit is 260°C.) Torion is not recommended for proton studies or for some carbon studies. As Torion has a relatively high moisture absorption rate .03%/24hours, it may be periodically necessary to bake out the turbine caps or tip caps at 50°C for one hour. This is necessary if the caps become too tight. (The opposite condition is much less likely. However, if one is in a very arid area or operating in a low moisture environment, the caps may have to be soaked in a liquid too make them tighter.)

Kel-F: A translucent white plastic, Kel-F is background free for all nuclei except F, Cl, and C. Kel-F is also excellent for carbon studies since the strong fluorine coupling effectively broadens the Kel-F carbon signal, and there are no protons to cross polarize. Kel-F is not as strong or wear resistant as the other cap materials and is thus restricted to lower spinning speeds. Kel-F turbine caps can be used at temperatures from -20°C to 70°C. (In non-spinning parts of the spinner assembly, the upper temperature limit is 130°C.)

Aurum*: This material is no longer available in appropriate form for our manufacturing, so Aurum is being replaced by Torlon. Aurum will be supplied if requested and is available, but supplies are severly limited.

This dark brown to black thermoplastic polyimide has excellent dielectric properties. Aurum can be used for low silicon applications when fast spinning is desired. Aurum is supplied for some probes designed for fluorine studies and other applications where carbon is not a problem. Turbine caps may be used from -30°C to 80°C repeatedly. (In non-spinning parts of the spinner assembly, the upper temperature limit is 240°C.)



Vespel: This brown plastic is used for some extended temperature caps and for non-spinning spinner assembly parts that will reach temperatures over 200°C. Vespel is not recommended for proton studies or for some carbon studies.

O-Ring Caps

For wet samples, air sensitive samples, and variable temperatures

O-ring Caps: Turbines and plug caps with dual Viton o-ring seals are available for Macor, silicon nitride, and zirconia rotors. Macor rotors, (available only for standard and high speed probes) are recommended for wet samples, air sensitive samples, and temperatures from -60°C to 250°C. A single (rear) cap with o-rings is used with a Macor rotor. However, if faster spinning is critical, VT and air-sensitive experiments can be done in silicon nitride or zirconia rotors using o-ring-sealed cap pairs. O-ring turbine caps are normally inserted and removed by hand. Turbines with threaded holes can be ordered with a threaded insertion tool for use when loading samples in a glove box (and to remove standard speed plug caps.) Caps can be ordered with axial outgassing holes for higher temperature work or to remove air bubbles.

Although the supersonic o-ring caps can be used for air sensitive samples in XC5 and XC7 probes, XC sealing cells are usually preferred.

- Kel-F O-ring Caps: Temperature range with o-rings: -45°C to 80°C.
- Aurum or Torlon O-ring Caps: Temperature range with o-rings: -45°C to 120°C.

Extended Temperature Caps

• DI, XC4 and XC5 probes (and most supersonic) use Glass-fiber-reinforced Torlon (GFT) – glued in.

GFT – if glued in: Temperature range: -170°C to 250°C

* Torlon is replacing aurum for most parts, depending on availability. Torlon can be used as a substitute for aurum as the NMR characteristics are similar.

Spinner Assembly Materials – Ceramics

Silicon Nitride: With a density of about 3.18 g/cm³ and a (working) tensile strength of 700 MPa, silicon nitride has the highest strength-to-weight ratio of any ceramic available today. Its hardness and toughness make it very difficult to grind, but it has the lowest dielectric loss and lowest permittivity of any engineering ceramic, making it the best choice for high frequencies. A HIPed (Hot Isostatic Pressed) variety is available with improved strength and dielectric properties. Its superior electrical properties make it the preferred material for most applications (often, even for silicon and nitrogen), because of silicon's long T_1 and nitrogen's low natural abundance. The color is black. The only additive or impurity greater than 200 ppm in this new material is yttria. Silicon nitride stators, housings, and rotors are available in all sizes. This material is required for fastest spinning.

Zirconia: This yttria-stabilized, high-purity material is glossy white and has a density of about 6 g/cm³ and a (working) tensile strength of 700 MPa. Alumina content can be kept below 100 ppm. Zirconia is less expensive than silicon nitride, but the safe spinning speed for zirconia rotors is lower than that of silicon nitride.

Macor: This white, machineable, boro-silicate glass-ceramic is loaded with synthetic mica to inhibit crack propagation. It is easily machined with conventional tooling. Macor housings may be provided for carbon and proton studies at temperatures over 160°C in our standard speed MAS probes. Macor is useable up to 650°C, but it has very poor thermal shock tolerance. Macor rotors are only available for the high speed and standard spinners. Macor rotors are made with a thicker wall and are machined with an integral turbine at one end. Standard speed rotors require a plug-cap at the open end, while high-speed rotors require a rear turbine. Macor rotors are recommended for wet samples, air-sensitive samples, and temperatures from -150°C to 250°C. Major constituents: AI, Si, O, B, K, F.

Boron Nitride: Boron Nitride is not used in Doty probes. However, the hexagonal hot-pressed variety, with 6% calcium borate binder, is easily machineable and is used for disposable inserts for the high-temperature ceramic rotors for the Doty high temperature probe (700°C). The material is soft enough to scratch easily and may absorb up to 1% moisture.



Doty MAS Spinning Speeds August 2014

See 3 mm next page.



MAS Turbine Cap Spinning Speeds									
	Maximum Spinning Speeds (kHz) For Caps at Room Temperature								
Cap Style	tyle 4 mm 5-mm XC or Su- perSonic 5-mm Stand- ard & High-Speed SuperSonic 7-mm Standard SuperSonic 8 High-Speed 5					10-mm XC, SuperSonic			
Kel-F	11	10	9	7	6	5			
Torlon or GFT	22	18	14	12	9	8.5			
Vespel	21	16	14	12	9	8			
Aurum	22	18	14	12	9	8.5			
Caps with o-rings		10	9	7	6	5			
Vespel w/screw			9	12	11	8			

Note: This chart represents <u>only</u> material characteristics for caps. Check the Probe Specifications. The spinning speed is often more limited by the probe or the rotor material.



3 mm Maximum MAS Spinning Speeds

Use the lower of the speeds listed: considering the rotor, the cap, the temperature and the density maximum speeds

Rotors: The maximum speed must be reduced as the density of the sample increases. Note- The maximum speed is temporarily limited to 26 kHz due to problems with material.							
DI3 Silicon Nitride Rotors	26 KHz	For sample density = 1					
Maximum Speed	26 KHz	For sample density = 3					
Maximum Spinning Speeds (kHz) For Caps at Room Temperature							
Con Stulo	DI-3 Spinning at	Cap Material Temperature					
Cap Style	Room Temperature	Range					
Torlon Front Turbine Cap	28 KHz	200 to 80.00					
Torlon Rear Tip Cap	28 KHz						
GFT* Front Turbine Cap	26 KHz	-120° to 160 °C					
GFT* Rear Tip Cap	26 KHz	-120 10 100 0					
Aurum Front Turbine Cap	18 KHz	-30° to 80 °C					
Aurum Rear Tip Cap	18 KHz	-50 10 00 0					
Kel-F Front Turbine Cap	11 KHz	-20° to 70 °C					
Kel-F Rear Tip Cap 11 KHz							
*Maximum Spinning Speeds (KHz) For Caps at Extended Temperatures Spinning speeds must be reduced for higher or lower temperatures.							

Glass Filled Torlon (GFT)*	14 KHz At -80°C	-120° to 160 °C
Glass Filled Torlon (GFT)*	14 KHz At +120°C	-120° to 160 °C

* Note: **GFT caps** can be used up to 250 °C or down to -170 °C if they are glued in with epoxy. **However the probe must be rated for these extended temperatures.**



Typical Specifications for Solids Probes

CRAMPS, Wide Line, MQ/MAS, H/F/X or F/X MAS,

Double-tuned, or Triple-tuned Probes

Although the versatile XC MAS probe can be supplied with one to four channels and upgraded at a later date, many customers prefer to order dedicated-purpose probes for lower cost or for specific requirements. Doty provides dedicated **CRAMPS**, **WIDELINE**, **Double-tuned**, **Triple-tuned**, **MQ/MAS**, and **HFX MAS**, to name a few. The following table provides typical specifications for some of these probes for the NB 500 MHz spectrometer. Specifications for other probes are available upon request.

500 MHz NB Solids. Standard Resolution. (For 40 mm RT shim bore, 5 mm sample.)												
Brief Description	VT range °C	Spinner, kHz	H/F γB₁ kHz	H/F P W	H/F dec. ms	Salt Toler.	¹³ C π/2 μs	¹³ C Power W	S/N, 4t	Widelin [,] ¹ H	e Backg ¹⁹ F	rounds ¹³ C
¹ H CRAMPS	-80/+120	Std, 1-9	160	400	-	High	-	-	-	~Zero	High	-
X WL	-80/+120	0	-	-	-	High	2.0	450	-	Mod.	High	Low
² H WL	-80/+120	0	-	-	-	High	2.0 ² H 90	975	-	Mod.	High	Low
H/X WL	-80/+120	0	120	300	150	High	2.6	700	240 ^A	Mod.	High	Low

500 MHz NB HR MAS Solids. XC Fast Spinner. (For 40 mm RT shim bore, 5 mm sample.)

Brief Description	VT range °C	Spinner, kHz	H/F γB₁ kHz	H/F P W	H/F dec. ms	Salt Toler.	¹³ C π/2 μs	¹³ C Power W	S/N, 4t	Wideline ¹ H	e Backg ¹⁹ F	rounds ¹³ C
H/X MAS*	-80/+120	XC 2 -18	65	190	50	Mod.	4.6	200	390 ^A	Mod.	High	Low
H/X MAS*	-160/+150	XC 2 -18	65	190	50	Mod.	4.6	200	390 ^A	Mod.	High	Low
H/X MAS	-80/+120	XC 2 -18	120	300	100	High	3.6	400	190 ^B	Mod.	High	Low
H/X MAS	-160/+150	XC 2 -18	120	300	100	High	3.6	400	190 ^B	Mod.	High	Low
F/X MAS	-160/+150	XC 2 -18	120	330	100	High	3.6	400	180 ^B	M. High	None	M. Low
H/X MAS/PFG	-15/+60	XC 2 -18	55	200	50	Mod.	4.6	225	390 ^A	Mod.	High	Low
H/X/Y MAS	-15/+60	XC 2 -18	120	300	100	High	3.6	400	180 ^B	Mod.	High	Low
H/X/Y MAS	-160/+150	XC 2 -18	120	300	100	High	3.6	400	180 ^в	Mod.	High	Low
H/F/X MAS	-80/+120	XC 2 -18	80/80	420	100/80	High	4.6	450	170 ^в	High	None	Mod.
H/F/X MAS	-160/+150	XC 2 -18	80/80	420	100/80	High	4.6	450	170 ^B	High	None	Mod.
H/F/X MAS	-160/+150	XC 2 -18	80/80	420	100/80	High	4.6	450	170 ^B	Mod.	High	Low
H/F/X MAS	-80/+120	XC 2 -18	80/80	420	100/80	High	4.6	450	170 ^B	Mod.	High	Low

All the above data are for 5 mm. S/N at RT; NF=1.2. **A:** non-spinning CP at 90° on HMB. **B:** CPMAS on glycine. Specifications listed for Triple Resonance probes are for DT configuration. For "High salt" probes, maximum X-channel B₁ is degraded during CP by ~20%, but ~40% for "Moderate salt" probes. Also available with SuperSonic Spinner. Specifications subject to change.



Ordering Information

Probes Are Available for All Spectrometer Users

+ Bruker + JEOL + Tecmag + Agilent/ Varian/ Chemagnetics

• Siemans • GE • Custom

Pricing

- There is a \$50 minimum per order.
- For probe prices, please request a quotation. This enables us to confirm prices and specifications.
- Shipping and handling charges will be prepaid and added to the invoice.
- Pricing is for U.S. domestic sales and subject to change without notice. Add 5% plus customs duties for Canada. Add 15% plus customs duties for foreign sales.

Volume Discounts For Rotors, Caps and Other Small Items								
Price Per Item	Quantity Per Line Item	Discount						
under \$ 100	4-9	10%						
under \$ 100	10 or more	20%						
\$100 - \$400	4-9	10%						
\$100 - \$ 400	10 or more	15%						
\$401 - \$1000	4-9	5%						
\$401 - \$1000	10 or more	10%						

Doty Scientific Warranty Information

DSI warrants that its products will conform to the specifications quoted when used with reasonable care within specifications, and in conjunction with properly performing instruments, for a period of one year from the date shipped. Exceptions: (1) Rotors and turbine caps are not covered under warranty because rotors and caps may be damaged by IMPROPER handling. Please follow the instructions in your manual. (2) Probe VT components may not be covered under warranty unless the probe is used with a DSI VT controller. Products requiring service or modification may be returned with freight, insurance, and handling fees prepaid. DSI will return repaired products freight prepaid. DSI assumes no responsibility for the repair or modification of products not provided by Doty Scientific.



MasterCard and Visa Are Accepted



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