

Adapted from
Vibracoustic

**Microcellular
Polyurethane (MCU)
Material Properties
Presentation**
(used with permission)

Body & Cradle Mounts



Vibraoustic

- MCU leader since 1972
- 10 Production lines
- Industry Technology Leader
- Industry Innovation Leader
- Industry Processing Leader
- Only Source for both MCU and Rubber

NDI

- Factory bump stops are typically made of rubber, even up to the early 90's. Most factory MCU bump stops are of an NDI brand, less expensive, less reliable and more prone to failure than FCM MCU bump stops.
- On many cars, suspension travel is severely limited with aftermarket lowering springs or if an end-user 'cuts' the springs
- Spring sag is common with time, further putting the user into the bump stops.
- High Durability High Volume Compressibility Low Dynamic Hardening
 - High Isolation, Low radial expansion upon compression

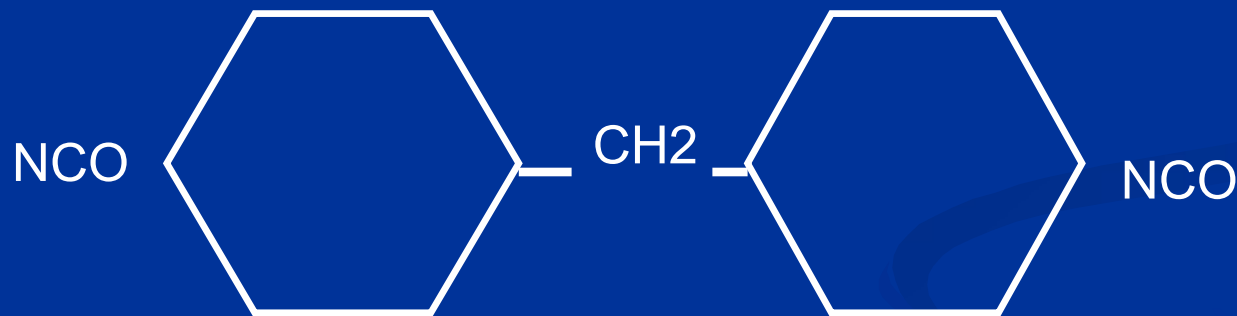


MDI

Methylenedipheylene-4-4-
Diisocyanate

Urethane Chemistry '101'

- MDI: Methylene diphenylene 4-4 diisocyanate

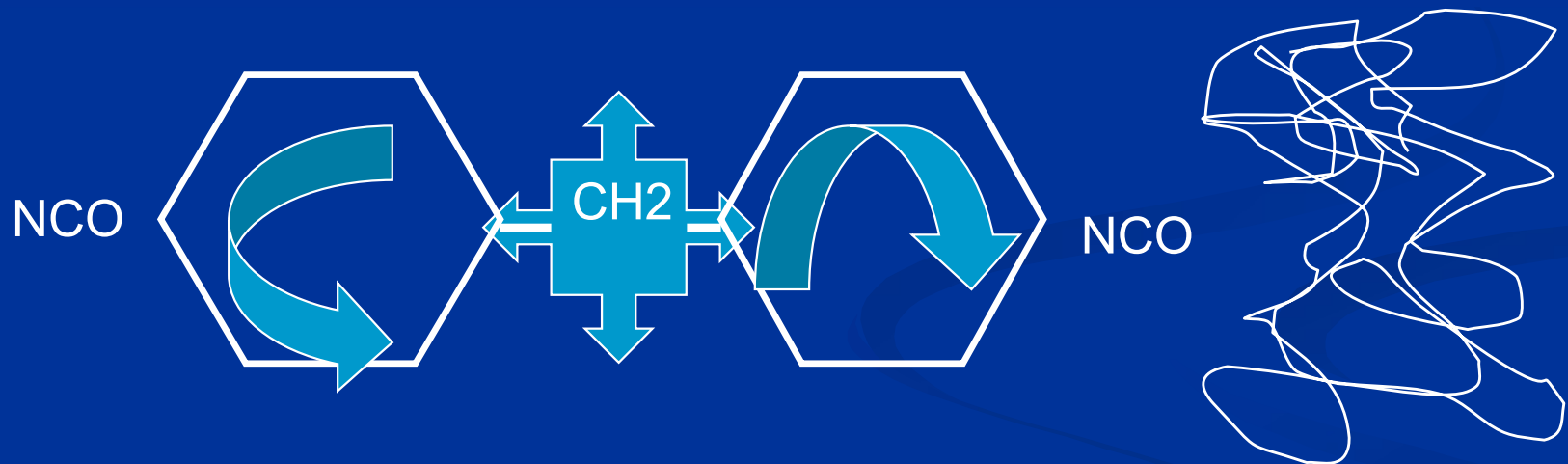


This methyl group has very little strength and allows great differences in orientation.

Urethane Chemistry '101'

Tumbleweed
orientation

- MDI: Methylene diphenylene 4-4 diisocyanate



This methyl group has very little strength and allows great differences in polymer chain orientation.

MDI

- Fairly New to NVH applications
- Higher dynamic stiffness vs. NDI
- Fair Durability
- Good volume compressibility
- Medium Damping
- Medium Isolation
- Low radial expansion upon compression

Bump stop selection guide

- Easier for factory MCU stops. Assume proper new bump stop length = old stop – amount of lowering. Choose the nearest length bump stop. For stiffer springs (at least double or triple stock rate), may go next shorter length.
- Example: Factory BMW stop 58mm. Lowering 25mm, choose FCM / Speedthane 36mm linear bump stop.
- Example Factory '06 MX5 bump stop is 68mm front, 76mm rear. Eibach lowering kit advertises 30mm stop, so new bump stop would be ~48mm or 58mm white plus a few spacers/ 'packers'.
- Spacers/packers allow customer to tune the balance without changing spring rates! Also good for stiffening handling at an event then removing the spacers for the ride home.

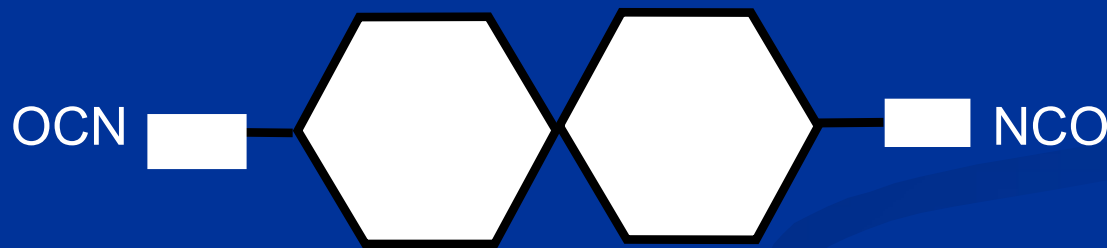


TODI

Biphenyl-Toluidine
Diisocyanate

Urethane Chemistry '101'

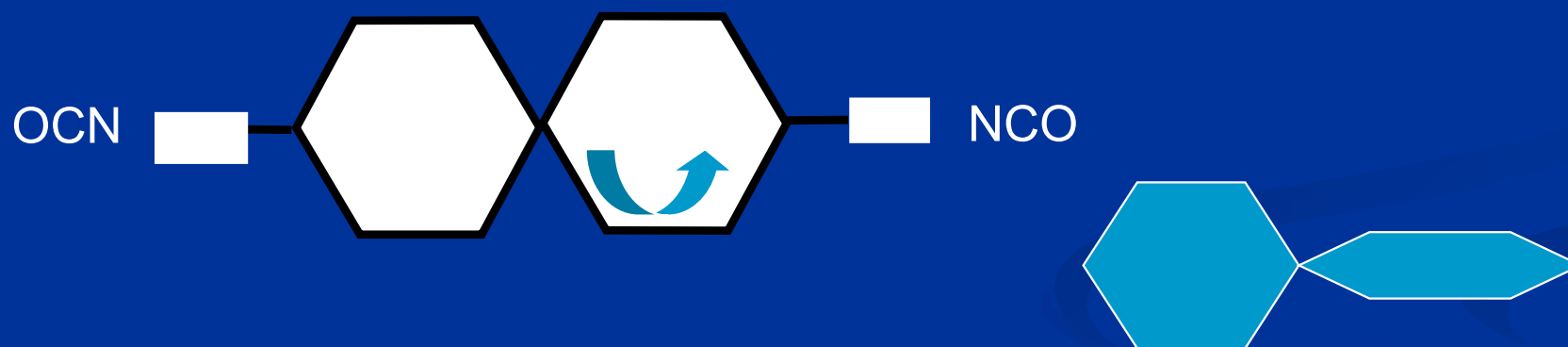
- TODI: Biphenyl toluene diisocyanate



Solid Carbon bond at the corner provides repeatable orientation and strength.

Urethane Chemistry '101'

- TODI: Biphenyltoulenediisocyanate



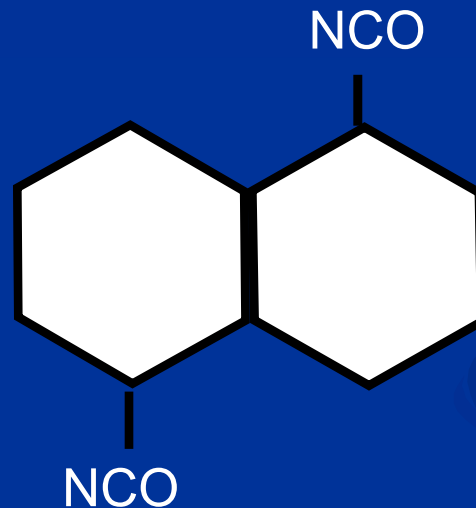
This rotated orientation stacks and nests much like the NDI, so we gain strength and durability from this structure.

NDI

*Napthalene- 1.5
Diisocyanate*

Urethane Chemistry '101'

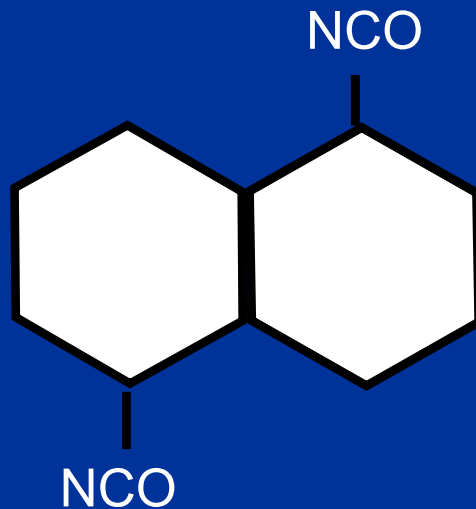
- NDI: Naphthalene-1,5 -diisocyanate



Carbon Double-Double bond has great strength, toughness, and provides very good orientation.

Urethane Chemistry '101'

- NDI: Naphthalene-1,5 -diisocyanate



Nested and Stacked
for Strength and
Toughness.



Carbon double-double bond had great strength, toughness, and provides very good orientation.

TODI

- Most common material for Jounce Bumper applications
- High Durability
- High Volume Compressibility
- Low Dynamic Hardening
 - Low Damping
 - High Isolation
- Low radial expansion upon compression



Urethane Properties

All urethanes are superior to rubber for the following:

- tear resistance
- elongation
- abrasion resistance
- oil resistance
- ozone resistance
- long term durability

Urethanes

- Within the urethane families there are important mechanical properties that certainly differentiate one chemistry from another.

Performance Characteristics

- Compression Set
- Heat Resistance
- Heat Buildup in service
- Permanent set in service
- Retention of Rate

Compression Set at Deflection

NDI	Static 5 %
TODI	Immediate Dynamic 11%
	Recovered Dynamic 9%
MDI	Static 10%
	Immediate Dynamic 21%
	Recovered Dynamic 20%

Static is 22 Hours at 70°C
100 hours recovery

Dynamic is 1 Million cycles 60% deflection

Compression Set at Load

	23°C		60 °C	
	10K	100K	10K	100K
NDI	3%	5%	8%	11%
TODI				
MDI	4%	6%	8%	18%

Cyclic load of 1.5Kn

Reduced Set keeps Vehicle heights constant.

Heat Resistance

- Melting Point

- NDI - Naphthalene base 127 °C
- TODI – Toulene base 78 °C
- MDI –Methyl base 38 °C

Cold Performance Drivers

- Cold performance is driven by the polyol family.
- Most MCUs are made from the Ester families.
- Some MDIs are made from the Ether family.
- Both families easily pass the -40 tests.

Structure

- NDI and TODI

- Ring structures that give superior toughness due to geometry.

- MDI

- Straight chains that do not have the strength derived by aromatic rings.

Heat Build up in Service

	Start Temp	Max Temp	delta T
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<50% cyclic deflection

■ NDI /TODI	23°	46°	23°
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■ MDI	23°	66°	43°
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> 50% cyclic deflection

■ NDI / TODI	23°	69°	46°
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■ MDI	23°	92°	69°
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Low heat build up improves durability.

Permanent set in service

Cycled at 18% and 25% OAH, then 1200N load applied

	18% flex	25% flex
■ NDI/TODI	4.4 % set	6.8% set
■ MDI	58 % set	destroyed

Lower Set obviously gives better retention of NVH over time and service.

Retention of Rate at 80° C

	23°C	80°C	% loss
Deflection at 1000N			
NDI	30%	35%	5%
MDI	47%	60%	13%
Max load at 60% compression			
NDI	6000N	4400N	26%
MDI	2100N	900N	57%

Summary

- NDI & TODI have shown superior mechanical characteristics.
- NDI & TODI have long histories of high performance in car and truck platforms.
- MDI cannot perform at the same level as the 2 premium isocyanate families.

MCU Advantages vs. Rubber

- High Volume Compressibility
- High Flexibility
- Lower Weight
- Lower Dynamic to Static Stiffness
- Resistance to chemicals
- Smooth progressive load-deflection

NDI/TODI advantages vs. MDI

- Rate less dependent on temperature.
- Better retention of rate under dynamic loading.
- Lower static and dynamic compression set.
- Lower heat build up in use.

Conclusion

- NDI/TODI are the clear favorites, when we consider long term vehicle performance. We must supply the customer with a vehicle that maintains it's desirable NVH over many years and many miles of use.

Vibraoustic

- Global NVH Engineering Company
- Global MCU expertise
- Rubber expertise
- Experienced in World Wide Programs
- Experienced in vehicle whole system tuning
- We have solved problems that others could not.
- We are the logical source of these programs.