INNOVATIVE PLASTICS

BOUNDLESS+ DYNAMIC

LNP™ SPECIALTY COMPOUNDS

Advanced gear solutions

CHEMISTRY THAT MATTERS™

A SABIC COMPANY

Innovative Plastics is a strategic business unit of SABIC. Founded in 1976, SABIC is today the first public, global multinational enterprise headquartered in the Middle East. Its products range from bulk commodity chemicals to highly engineered plastics for demanding applications. It is a leading producer of polyethylene, polypropylene, glycols, methanol and fertilizers and the fourth largest polyolefin producer.

SABIC's businesses are grouped into Chemicals, Performance Chemicals, Polymers, Innovative Plastics, Fertilizers and Metals. It has significant research resources with dedicated Technology & Innovation centers in Saudi Arabia, the Netherlands, Spain, the USA, India, China and Japan.

INNOVATING FOR CUSTOMER SUCCESS

We believe that SABIC customers deserve the full benefit of every advantage our enterprise can offer. After all, our success is defined by our customers' success. And with more than 80 years of experience pioneering advanced engineering thermoplastics, SABIC's Innovative Plastics business is positioned to help create new opportunities for growth and breakthrough applications.

We offer expertise and experience to our customers in a variety of ways:

- Material solutions to help drive innovation and market leadership.
- Design, logistics and processing expertise to spark new ideas and better efficiencies.
- Unwavering commitment to build long-term relationships with ingenuity, trust and continuous improvement.

It's what we strive for and work to deliver… a mutual benefit.

Excellence and nothing less.

ADVANCED GEAR SOLUTIONS

There are times when a single resin like POM may not provide the performance needed for advanced gears. The SABIC product portfolio is based on a variety of thermoplastic resins in combination with different internal lubricants.

- Available in >20 different resins
- Based on six different lubricants and combinations
- Available in unfilled and filled versions (glass/carbon fiber, mineral)
- UL94 V0 grades are available

WHERE POM MAY NOT WORK

- High accuracy requirements
- Low noise requirements
- Tooth stress > 43 MPa
- Temperature >80 °C
- Enhanced wear and/or friction
- Agency flame requirement > HB

HIGH ACCURACY

- LUBRILOY™ D2000 compound
- LUBRILOY D20001 compound
- LUBRICOMP™ DFL36 compound
- LUBRICOMP EFL36 compound
- and other compounds

NOISE REDUCTION

- LUBRILOY R2000 compound
- LUBRILOY D2000 compound
- LUBRILOY D20001 compound
- LUBRICOMP KL004 compound
- and other compounds

HIGH HEAT/HIGH TORQUE

- LUBRICOMP EFL36 compound
- LUBRICOMP OFL36 compound
- LUBRICOMP UFL36S compound
- VERTON™ RV00AES compound
- and other compounds

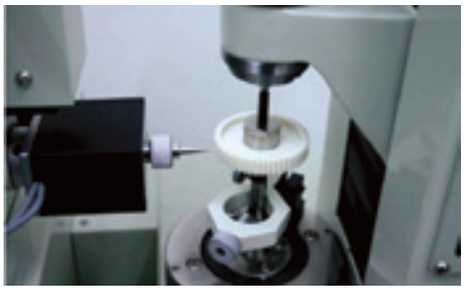
PRIMARY GEAR GRADES

LUBRILOY D2000 compound	PC	High impact, good dimensional stability
LUBRILOY D2001 compound	PC (FR)	Environmentally friendly flame resistance, good dimensional stability
LUBRILOY R2000 compound	PA66	Good chemical resistance, low SG and noise
LUBRICOMP KL004 compound	POM, PTFE	Low wear factor, superior friction
LUBRICOMP DFL36 compound	PC, GF & PTFE	High strength, good dimensional stability
LUBRICOMP WFL36 compound	PBT, GF & PTFE	High strength, well-balanced performance
LUBRICOMP RFL36 compound	PA66, GF & PTFE	High strength, good chemical resistance
LUBRICOMP OFL36 compound	PPS, GF & PTFE	High strength, high heat resistance
LUBRICOMP EFL36 compound	PEI, GF & PTFE	High heat resistance, good dimensional stability
LUBRICOMP UFL36S compound	PPA, GF & PTFE	Exceptional L-PV, high heat resistance
LUBRICOMP LCL33E compound	PEEK, CF & PTFE	Superior high heat resistance, high strength
VERTON RV00AES compound	PA66, L-GF	Superior high strength, good weld-line strength

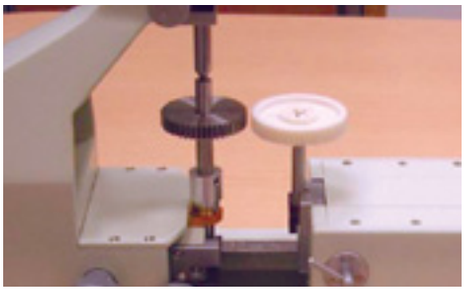
TESTING

ACCURACY

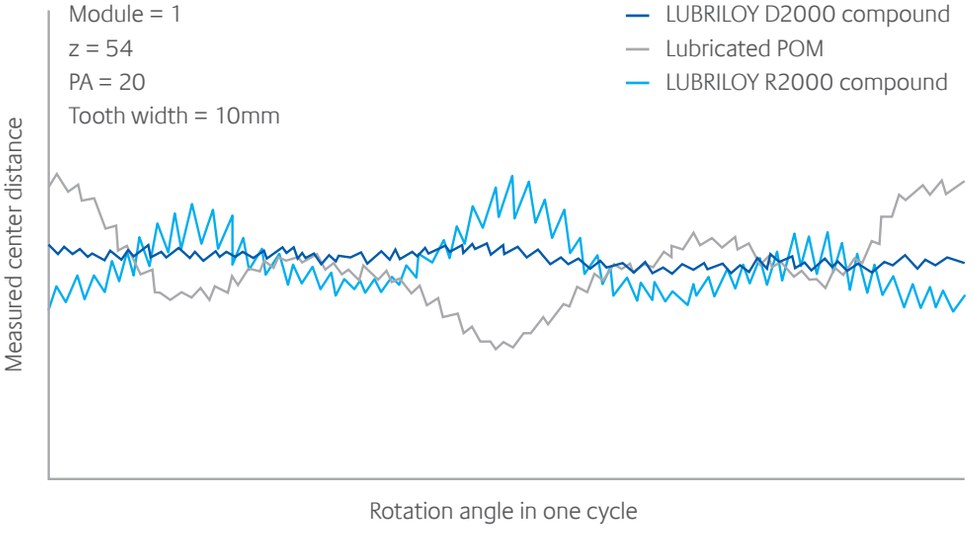
A rolling test is a typical way of measuring gear accuracy. A dual contact rolling test detects the center distance between the master gear (which is of known high quality) and the sample gear, as they are forced to mesh with each other. The measured value is the composite gear error.



CNC TOOTH PROFILE TESTER
TTi-120E (Tokyo Technical Instruments, Inc.)



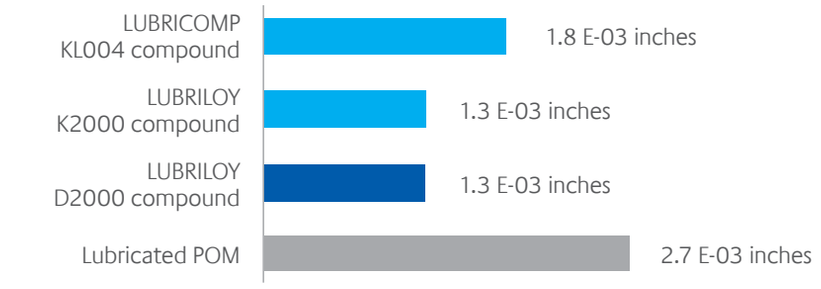
ROLLING TESTER
TF-40NC (Tokyo Technical Instruments, Inc.)



GEAR WEAR

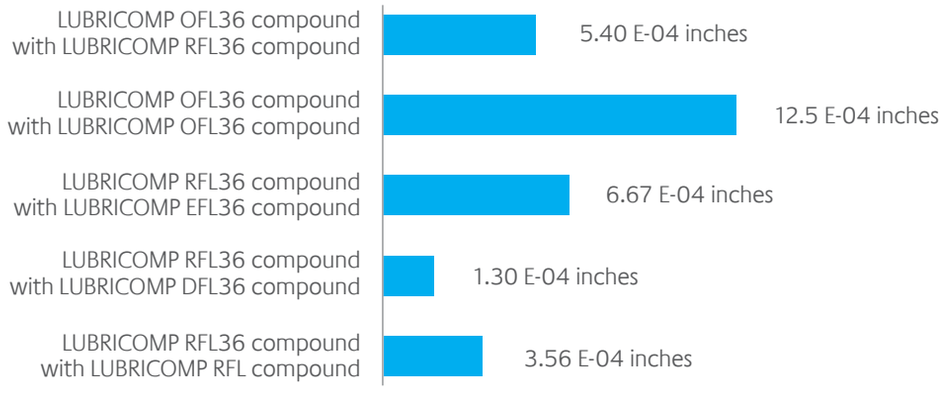
Gear wear test data at room temperature after 5 million revolutions

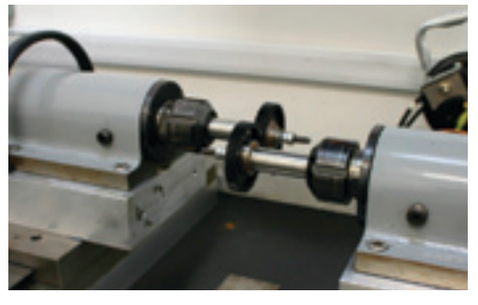
MATED WITH LUBRICATED POM



Module = 1, z = 54, PA = 20, Speed = 509 rpm, Torque = 2.51Nm

MATED WITH SAME OR OTHERS





GEAR WEAR TESTER
LRI-2GL, GH (Lewis Research, Inc.)

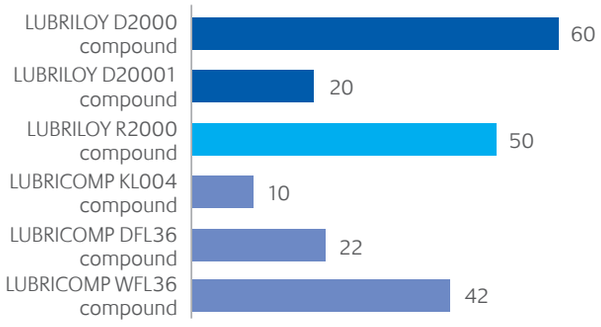
LRI-2GL and GH are the computer-controlled gear wear testers monitoring backlash by rotary encoders equipped at AC servomotors. The highest motor speed is 4,000 rpm and torque limitation is 80 in-lb. LRI-2GH has a chamber to keep environmental temperature up to 260 °C.

TESTING

THRUST WASHER WEAR TEST

Thrust washer wear test data at room temperature

LNP COMPOUNDS WEAR FACTOR K VS. STEEL

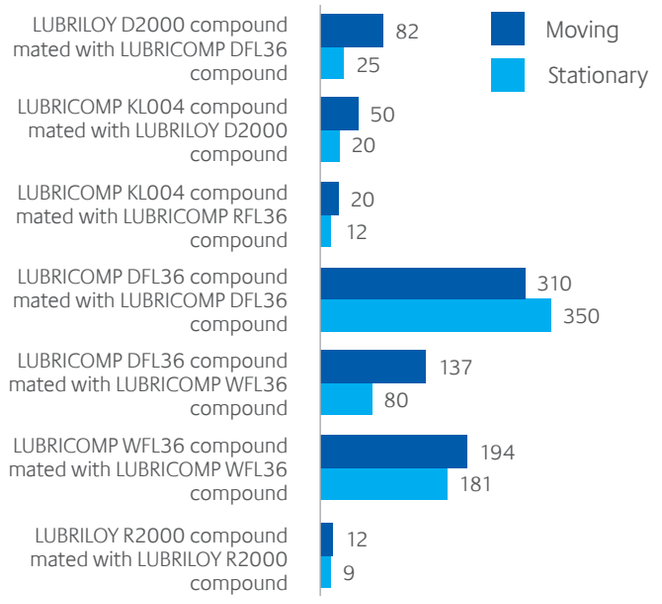


LNP COMPOUNDS WEAR FACTOR K

$$K_{LNP} = \frac{W}{P \bullet V \bullet T}$$

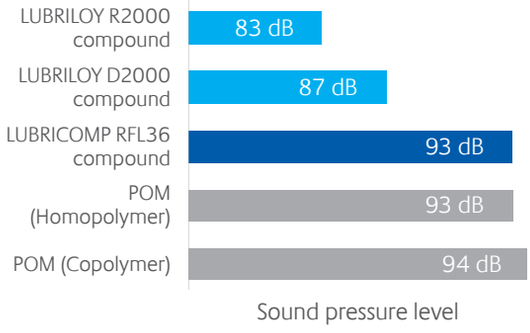
W = Volume wear (in^3 or mm^3)
P = Pressure (lbs/in^2 or pascals)
V = Velocity (ft/min or m/s)
T = Elapsed time (hours)

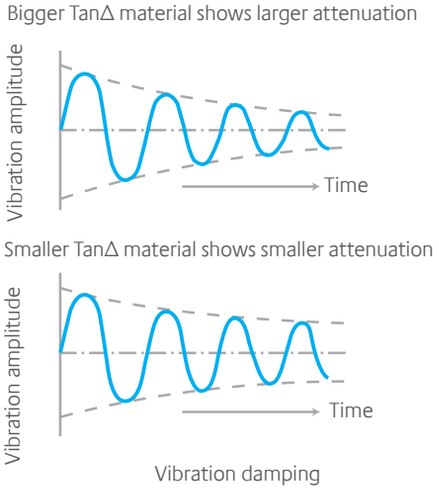
LNP COMPOUNDS WEAR FACTOR K



NOISE REDUCTION

Noise measurement example





TanΔ value at 100 Hz

Bigger

Polyester Elastomer: 0.119

LUBRILOY R2000: 0.051

LUBRILOY D2000: 0.027

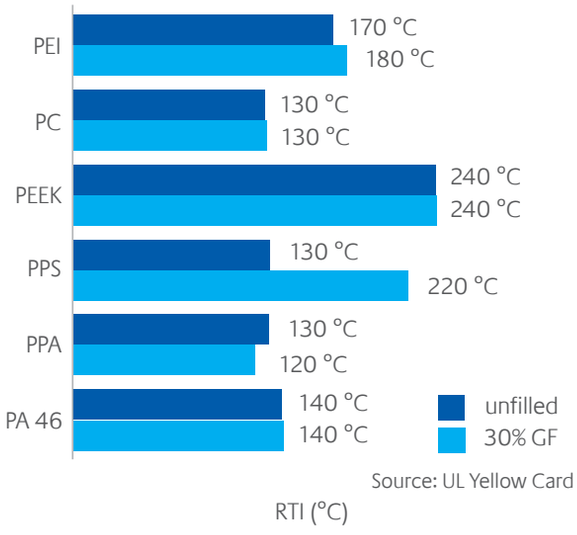
Lubricated POM: 0.020

Smaller

at DMA (Dynamic Mechanical Analysis) testing

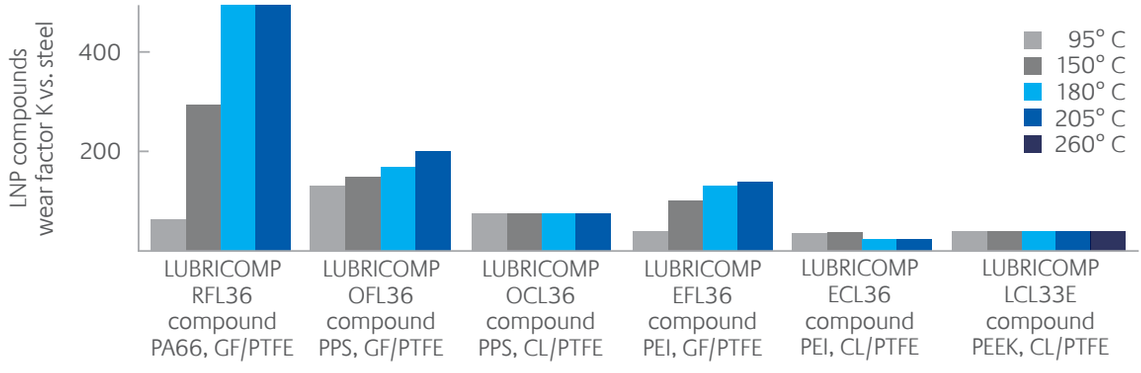
HIGH TEMPERATURE

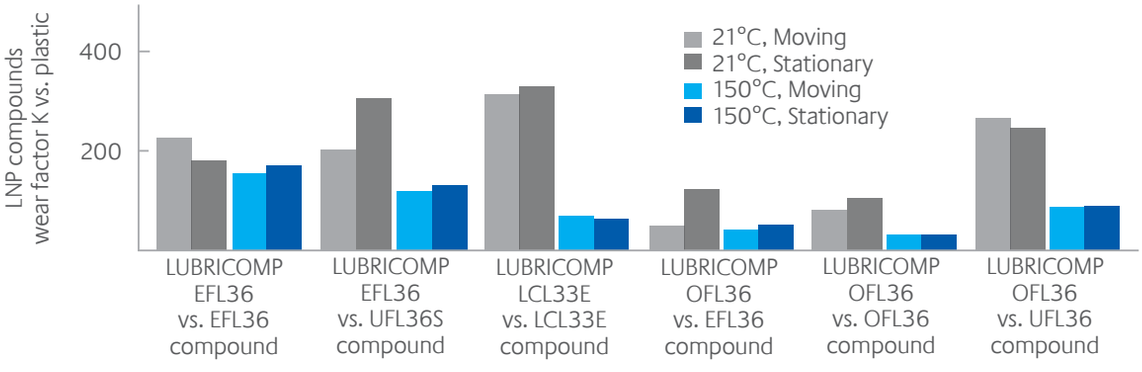
RTI of various materials



THRUST WASHER TRIBOMETER
LRI-1a (Lewis Research, Inc.)

THRUST WASHER WEAR TEST DATA

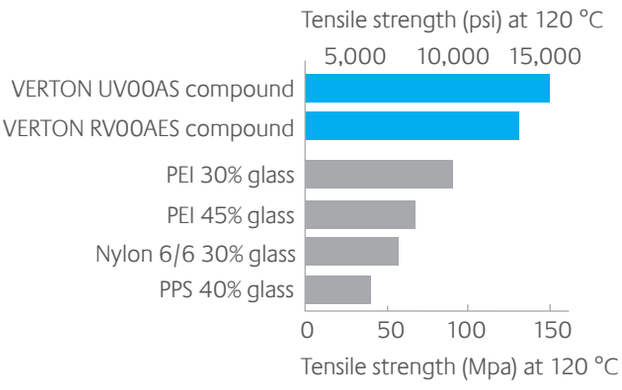




TESTING

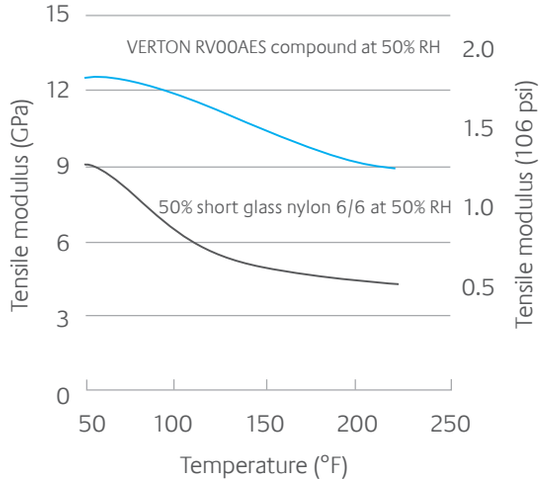
VERTON COMPOUNDS

VERTON long glass fiber reinforcement provides enhanced mechanical properties, making it one of the most suitable options for metal replacement.



VERTON PPA and PA66 structural compounds outperform traditional “high temperature resins” at elevated temperatures.

TENSILE MODULUS VS. TEMPERATURE



VERTON PA66 structural composites offer superior stiffness.

METAL REPLACEMENT

LNP specialty compounds are ideal for replacing metal gears. They can offer design flexibility and improved performance over the life of the product as well as manufacturing advantages and cost savings.

LOWER COST THAN METAL, PLUS

- Lighter weight
- Quieter
- Self-lubricated
- Lower inertia
- Corrosion resistance
- Parts consolidation

NEW PRODUCT DEVELOPMENT

- Part design recommendations
- Material recommendations
- Tooling design recommendations

COST CALCULATION EXAMPLE

$2.33 – $2.80

Metal gear: 22.10 cm^3
When SG is 7.8, weight is 172.4 g

$0.73

Plastic gear: 9.26 cm^3
When SG is 1.3, weight is 12.04 g

TYPICAL PRICE COMPARISON

Sintered metal gear cost
$2.33 = powder metal $1.10 + sintering $1.00 + secondary $0.23 or machined metal gear $2.80 = metal blank $0.60 + machining $2.20
vs. plastic gear $0.73 = resin $0.48 + injection molding $0.25.

PLASTIC GEAR DESIGN WIZARD (PGDW)

PGDW is a software that calculates “tooth root stress” using the Lewis equation; it calculates material “permissible bending stress” based on SABIC’s Innovative Plastics business’ original algorithm.

- Plastic material focus – Incorporating database from SABIC’s Innovative Plastics business
- Internal technical analysis standard for plastic gears – New design methodology to translate the material data into gear analysis data
- New gear design factor introduction – Friction factor/contact ratio factor

SABIC Innovative Plastic Home → New Engineering Tools → Plastic Gears

$$\sigma_F = \frac{F}{b \cdot m \cdot Y}\left(\frac{K_f}{K_e}\right)$$

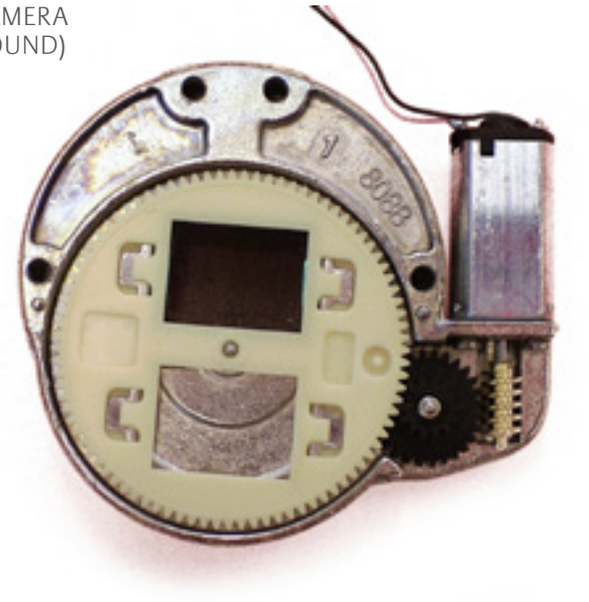
σ_F = Tooth root stress
F = Tangential load at reference circle
b = Face width
m = Module
Y = Lewis’s form factor
K_f = Friction factor
K_e = Contact ratio factor

$$\sigma_{FP} = \frac{\sigma_m}{C_3} \cdot K_V \cdot K_T \cdot K_L \cdot K_M \cdot K_{life}$$

σ_{FP} = Permissive bending stress
σ_m = Nominal stress number
C_S = Service factor
K_V = Velocity factor
K_T = Temperature factor
K_L = Lubrication factor
K_M = Mated material factor
K_{life} = Life factor

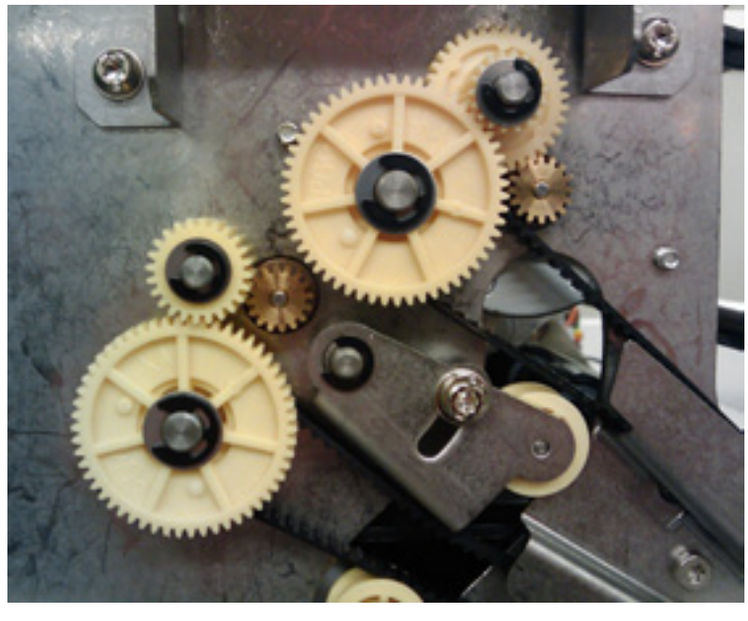
APPLICATION EXAMPLES

BOSCH SECURITY CAMERA
(LUBRICOMP COMPOUND)



UNDERHOOD ELECTRONIC
THROTTLE BODY GEAR
(LUBRICOMP COMPOUND)

DOCUMENT HANDLING GEARS
(LNP SPECIALTY COMPOUNDS)



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