Advanced® Couplings Limited

ACL®
Anti-galling Clamps

There is an issue throughout the industry of 'galling' on hygienic clamps. As the clamps are un-lubricated, dissimilar metals must be used to resist the adhesive wear from galling.

ACL has a solution for this; the Anti-galling Clamp. Due to the silicon and manganese content, Nitronic 60 is much more resistant to galling than other stainless steels.

The threaded portions of the clamp can be supplied in most materials that the end-user would require. However, it should be noted that ACL's standard is Nitronic 60 eyebolt with a 304 or 316 nut.

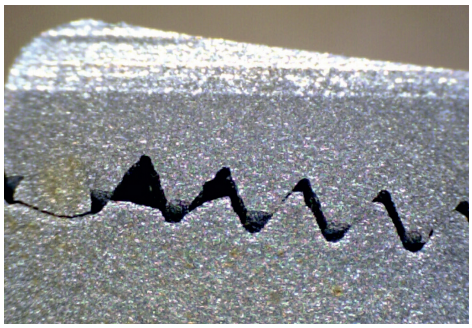
The following options are available from our stock:

- Nitronic 60 standard eyebolt
- Nitronic 60 safety eyebolt
- Nitronic 60 hex nut
- Nitronic 60 safety hex nut

What is 'galling'?

"Galling, or cold welding as it is sometimes referred to, is a form of severe adhesive wear. Adhesive wear occurs between two metal surfaces that are in relative motion and under sufficient load to permit the transfer of material. This is a solid-phase welding process. The load must be sufficient, during relative motion, to disrupt the protective oxide layer covering surface asperities of the metal and permit metal to metal contact. Under high stress and poor lubrication conditions, stronger bonds may form over a larger surface area. Large fragments or surface protrusions may be formed and the result is galling of the surfaces. Severe galling can result in the seizure of metal components.

Materials which are highly ductile or which possess low work-hardening rates tend to be prone to galling. Austenitic stainless steels show a tendency to gall under certain conditions."



Galled threads (both materials 316)

Advantages

- Increased service life
- Less likely to gall resulting in forced removal
- Higher resistance to CIP cleaning solution residue
- Increased consistency of torque values after COP
- Reduced particulate generation

Source: BSSA (2018) Improving wear and galling resistance of stainless steels. https://www.bssa.org.uk/topics.php?article=13 Accessed: 03.12.19

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Nitronic 60
Chemical Composition

Element	Min %	Max %
C	-	0.1
Si	3.5	4.5
Mn	7	9
Ni	8	9
Cr	16	18
S	-	0.03
P	-	0,04
Mo	-	0.75
N	0.08	0.18
Cu	-	0.75
Fe	bal	

"Nitronic 60 (Alloy 218, UNS S21800) is known for its excellent galling resistance, even at elevated temperatures and low temperature impact resistance. The additions of 4% silicon and 8% manganese inhibit wear, galling and fretting. It is commonly used for various fasteners and pins that require strength and resistance to galling. It maintains decent strength up to temperature of 1800F and has oxidation resistance similar to that of 309 stainless steel. The general corrosion resistance is between that of 304 and 316 stainless steel and the yield strength is twice that of 304 and 316."

Source: Shanghaimetal (-) Nitronic 60 Round Bar
https://www.shanghaimetal.com/nitronic_60_round_bar
Accessed 03.12.19

Unlubricated Galling Resistance of Stainless Steels / Threshold Galling Stress in ksi (MPa)
Stress at which galling began

Conditions and Nominal Hardness (Brinell)	Type 410	Type 416	Type 430	Type 440C	Type 303	Type 304	Type 316	17.4 PH	Nitronic 32	Nitronic 60
Hardened and Stress Relieved (352) Type 410	3 (21)	4 (28)	3 (21)	3 (21)	4 (28)	2 (14)	2 (14)	3 (21)	46 (317)	50 + (345)
Hardened and Stress Relieved (342) Type 416	4 (28)	13 (90)	3 (21)	21 (145)	9 (62)	24 (165)	42 (290)	2 (14)	45 (310)	50 + (345)
Annealed (159) Type 430	3 (21)	3 (21)	2 (14)	2 (14)	2 (14)	2 (14)	2 (14)	3 (21)	8 (55)	36 (248)
Hardened and Stress Relieved (560) Type 440C	3 (21)	21 (145)	2 (14)	11 (76)	5 (34)	3 (21)	37 (255)	3 (21)	50 + (345)	50 + (345)
Annealed (153) Type 303	4 (28)	9 (62)	2 (14)	5 (34)	2 (14)	2 (14)	3 (21)	3 (21)	50 + (345)	50 + (345)
Annealed (140) Type 304	2 (14)	24 (165)	2 (14)	3 (21)	2 (14)	2 (14)	2 (14)	2 (14)	30 (207)	50 + (345)
Annealed (150) Type 316	2 (14)	42 (290)	2 (14)	37 (255)	3 (21)	2 (14)	2 (14)	2 (14)	3 (21)	38 (262)
H950 (415) 17.4 PH	3 (21)	2 (14)	3 (21)	3 (21)	2 (14)	2 (14)	2 (14)	2 (14)	50 + (345)	50 + (345)
Annealed (235) Nitronic 32	46 (317)	45 (310)	8 (55)	50 + (345)	50 + (345)	30 (207)	3 (21)	50 + (345)	30 (207)	50 + (345)
Annealed (205) Nitronic 60	50 + (345)	50 + (345)	36 (248)	50 + (345)	50 + (345)	50 + (345)	38 (262)	50 + (345)	50 + (345)	50 (345)

\+ Did not gall | Current | Anti-galling

Note: Condition and hardness apply to both horizontal and vertical axes.

Source: HP Alloys (2011) Nitronic 60 stainless steel bar and wire (UNS-S21800), Windfall, IN: HP Alloys.

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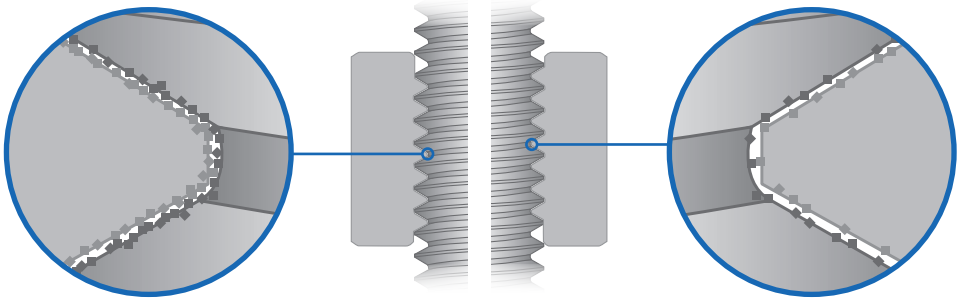
Particulate Generation

As Nitronic 60 is more resistant to this mechanism of wear, there is less particulate generated by on / off cycles. This makes the anti-galling clamp a perfect solution for clean room environments. In addition to the reduction of galling, end users can also have a 'cleaner' product.



Example of heavy particulate generation (316 / 316)

Example of light particulate generation (N60 / 304)

Wear Compatibility of Stainless Steel Couples

Alloy		Weight Loss (mg/1,000 cycles)						
		Type 304	Type 316	17.4 PH	Nitronic 32	Nitronic 50	Nitronic 60	Type 440C
Hardness Rockwell	vs.	B99	B91	C43	B95	B99	B95	C57
Type 304		12.8						
Type 316		10.5	12.5					
17.4PH		24.7	18.5	52.8				
Nitronic 32		8.4	9.4	17.2	7.4			
Nitronic 50		9.0	9.5	15.7	8.3	10.0		
Nitronic 60		6.0	4.3	5.4	3.2	3.5	2.8	
Type 440C		4.1	3.9	11.7	3.1	4.3	2.4	3.8

Current Anti-galling

Source: HP Alloys (2011) Nitronic 60 stainless steel bar and wire (UNS-S21800), Windfall, IN: HP Alloys.

Quality Assurance

The ACL Quality Management System is certified according to EN ISO 9001:2015. We ensure that our suppliers also maintain a certified Quality Management System.

ACL's anti-galling clamps are European originating goods and are tested in accordance with our strict procedures, ensuring the highest level of reliability and safety.

Further Information

For detailed selection criteria, technical information, installation guidelines or to contact ACL, please visit our website:

www.advanced-couplings.com

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Unlubricated Galling Resistance of Several Metal Combinations

Couple - (Brinell Hardness)			Threshold Galling Stress ksi (MPa) (Stress at which galling began)
Waukesha 88 (141)	vs.	Type 303 (180)	50 + (345)
Waukesha 88 (141)	vs.	Type 201 (202)	50 + (345)
Waukesha 88 (141)	vs.	Type 316 (200)	50 + (345)
Waukesha 88 (141)	vs.	17-4 PH (405)	50 + (345)
Waukesha 88 (141)	vs.	20 Cr-80 Ni (180)	50 + (345)
Waukesha 88 (141)	vs.	Type 304 (207)	50 + (345)
Silicon Bronze (200)	vs.	Silicon Bronze (200)	4 (28)
A-286 (270)	vs.	A-286 (270)	3 (21)
Nitronic 60 (205)	vs.	A-286 (270)	49 + (338)
Nitronic 60 (205)	vs.	20 Cr-80 Ni (180)	36 (248)
Nitronic 60 (205)	vs.	Ti-6Al-4V (332)	50 + (345)
AISI 4337 (484)	vs.	AISI 4337 (415)	2 (14)
AISI 1034 (415)	vs.	AISI 1034 (415)	2 (14)
Nitronic 60 (205)	vs.	AISI 4337 (448)	50 + (345)
Nitronic 60 (205)	vs.	Stellite 6B (415)	50 + (345)
Nitronic 32 (234)	vs.	AISI 1034 (205)	2 (14)
Nitronic 32 (231)	vs.	Type 201 (202)	50 + (345)
Nitronic 60 (205)	vs.	17-4 PH (322)	50 + (345)
Nitronic 60 (205)	vs.	Nitronic 50 (205)	50 + (345)
Nitronic 60 (205)	vs.	PH 13-8 Mo (297)	50 + (345)
Nitronic 60 (205)	vs.	PH 13-8 Mo (437)	50 + (345)
Nitronic 60 (205)	vs.	15-5 PH (393)	50 + (345)
Nitronic 60 (205)	vs.	15-5 PH (283)	50 + (345)
Nitronic 60 (205)	vs.	17-7 PH(404)	50 + (345)
Nitronic 60 (205)	vs.	Nitronic 40 (185)	50 + (345)
Nitronic 60 (205)	vs.	Type 410 (240)	36 (248)
Nitronic 60 (205)	vs.	Type 420 (472)	50 + (345)
Nitronic 60 (210)	vs.	Type 201 (202)	46 + (317)
Nitronic 60 (210)	vs.	AISI 4130 (234)	34 (234)
Nitronic 60 (205)	vs.	Type 301 (169)	50 + (345)
Type 440C (600)	vs.	Type 420 (472)	3 (21)
Type 201 (202)	vs.	Type 201 (202)	20 (137)
Nitronic 60 (205)	vs.	Cr plated Type 304	50 + (345)
Nitronic 60 (205)	vs.	Cr plated 15-5PH (H1150)	50 + (345)
Nitronic 60 (205)	vs.	Inconel 718 (306)	50 + (345)
Nitronic 60 (205)	vs.	CP Titanium (185)	47 + (324)
Nitronic 60 (205)	vs.	Ni Resist Type 2 (145)	50 + (345)
Nitronic 60 (205)	vs.	Stellite 21 (295)	43 + (296)

Couple - (Brinell Hardness)			Threshold Galling Stress ksi (MPa) (Stress at which galling began)
Type 201 (202)	vs.	Type 304 (140)	2 (14)
Type 201 (202)	vs.	17-4 PH (382)	2 (14)
Type 410 (322)	vs.	Type 420 (472)	3 (21)
Type 304 (140)	vs.	AISI 1034 (205)	2 (14)
Type 304 (337)	vs.	Type 304 (337)	2 (14)
Type 304 (207)	vs.	Type 304 (337)	2 (14)
Duplex 2205 (235)	vs.	Type 303 (153)	2 (14)
Duplex 2205 (235)	vs.	Type 304 (270)	2 (14)
Duplex 2205 (235)	vs.	Type 316 (150)	2 (14)
Duplex 2205 (235)	vs.	Type 416 (342)	2 (14)
Duplex 2205 (235)	vs.	17-4 PH (415)	2 (14)
Duplex 2205 (235)	vs.	Nitronic 60 (210)	30 (207)
IN 625 (215)	vs.	Type 303 (153)	2 (14)
IN 625 (215)	vs.	Type 304 (270)	2 (14)
IN 625 (215)	vs.	Type 316 (161)	2 (14)
IN 625 (215)	vs.	17-4 PH (415)	2 (14)
IN 625 (215)	vs.	Nitronic 60 (210)	33 (227)
Stellite 21 (270)	vs.	Type 316 (161)	2 (14)
Stellite 21 (270)	vs.	Nitronic 50 (210)	2 (14)
Stellite 21 (270)	vs.	Nitronic 60 (210)	43 + (297)
K-500 Monel (321)	vs.	Type 304 (270)	2 (14)
K-500 Monel (321)	vs.	Type 316 (161)	2 (14)
K-500 Monel (321)	vs.	17-4 PH (415)	2 (14)
K-500 Monel (321)	vs.	Nitronic 50 (245)	2 (14)
K-500 Monel (321)	vs.	Nitronic 60 (210)	17 (117)
Nitronic 60 (210)	vs.	Tribaloy 700 (437)	45 + (310)
Stellite 68 (450)	vs.	Type 316 (61)	8 (55)
Stellite 68 (450)	vs.	Type 304 (150)	47 + (324)
Stellite 68 (450)	vs.	Nitronic 60 (210)	50 + (345)
Type 410 (210)	vs.	Type 410 (210)	2 (14)
Type 410 (363)	vs.	Type 410 (363)	2 (14)
Type 410 (210)	vs.	Type 410 (363)	2 (14)
17-4 PH (H1150 + H1150) (313)	vs.	17-4 PH (H1150 + H1150) (313)	2 (14)
Type 410 (210)	vs.	17-4 PH (H1150 + H1150) (313)	2 (14)
Nitronic 60 (210)	vs.	17-4 PH (H1150 + H1150) (313)	21 (145)
Nitronic 60 (210)	vs.	Type 410 (210)	24 (165)

\+ Did not gall

Source: HP Alloys (2011) Nitronic 60 stainless steel bar and wire (UNS-S21800), Windfall, IN. HP Alloys.