

NDR™ Wire

Definition

NDR is an acronym: Nanograin Damage Resistant. NDR is a process which comprises a thermal-mechanical treatment designed to produce nanoscale microstructural refinement. This refinement is evidenced by a significant increase in the material's ability to resist damage during high cycle mechanical loading, as encountered, for example, during the service of a long-term cardioverter defibrillator lead implant due to pulsating stresses.

Typical Alloys

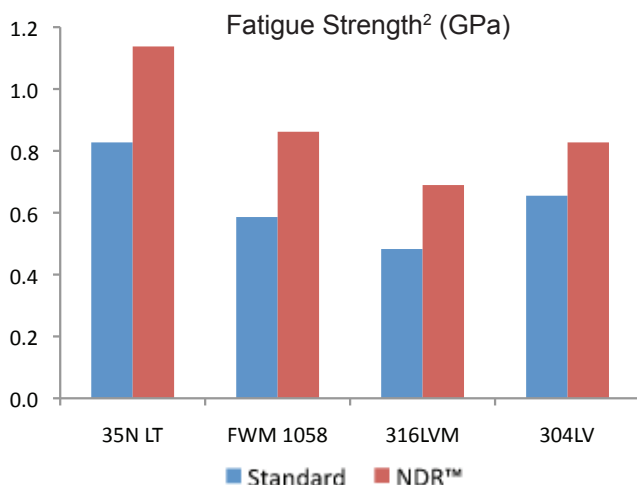
The NDR process may be applied to non-precipitation hardening, non-sensitizing, implant-grade alloys such as those called out by ASTM F562 alloy (35N LT® wire or MP35N® wire), ASTM F1058 (FWM 1058® wire) and ASTM F138 (316LVM).

Typical Fatigue Results¹

	Fatigue Strength ² , GPa (ksi)		
	Standard	NDR Wire	Change
ASTM F562 (35N LT)	0.83 (120)	1.1 (165)	38%
ASTM F1058 (FWM 1058)	0.59 (85)	0.86 (125)	47%
ASTM F138 (316LVM)	0.48 (70)	0.67 (98)	40%
ASTM A580 (304LV)	0.65 (95)	0.86 (125)	32%

¹ Typical results for 0.18 mm (.007") drawn wire. While these results are typical, they represent data from a single laboratory exercise and will not translate directly to each application.

² Fatigue Strength: stress amplitude in a fully reversed rotary beam fatigue test at 1x10⁷ cycles calculated using published moduli for each alloy.

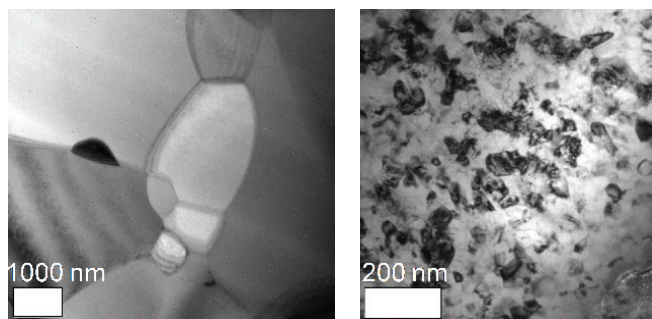


Physical Properties

NDR processing does not change the chemical or atomic makeup of the parent alloy system. Properties such as density, electrical resistivity, thermal conductivity and thermal coefficient of expansion are similar before and after the application of NDR technology.

High Performance

The performance of NDR wire is attributable to the underlying microstructure. Conventional microstructure is shown below (left), where the average breadth of each grain is 2 microns. The next image (right) shows NDR-refined microstructure where similar features are on the order of 200 nm.



Conventional

NDR-microstructure

Example Mechanical Properties

The tensile mechanical properties of NDR wire are similar to conventional wire. Three examples of possible properties for 35N LT alloy are given below.

Example Mechanical Properties

Temper:	35N LT NDR Wire			35N LT Conventional Wire		
	ANLD	Hard	Spring	ANLD	Hard	Spring
Ultimate Strength GPa (ksi)	1.45 (210)	1.79 (260)	2.21 (320)	1.31 (190)	1.79 (260)	2.21 (320)
0.2% Yield Strength GPa (ksi)	1.31 (190)	1.45 (210)	2.00 (290)	0.69 (100)	1.45 (210)	2.00 (290)
Rupture Strain (%)	15	4	2	35	4	2
Fatigue Strength GPa (ksi)	1.14 (165)	1.21 (175)	1.14 (165)	0.62 (90)	0.83 (120)	0.93 (135)