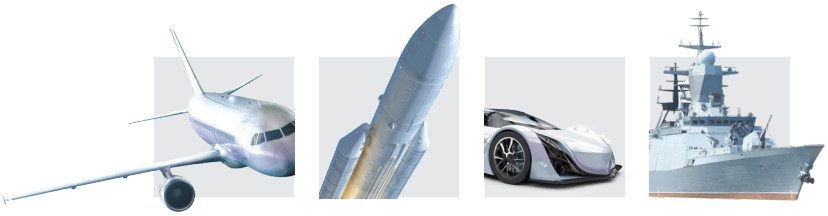
AUBERT&DUVAL

HIGH PERFORMANCE STEELS FOR TRANSMISSIONS SYSTEMS



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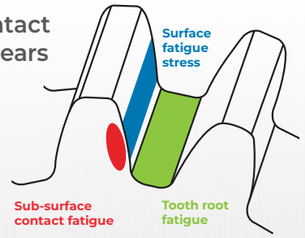
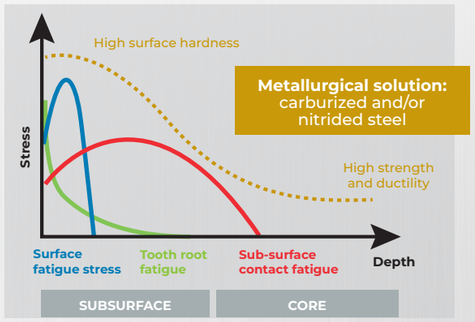
Under the load: Mechanical stresses on gears and bearings

In power transmission systems, there are two main families of components: gears and bearings. They are subjected to different types of stress, as illustrated below:

Gear application

Example of contact between two gears

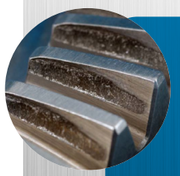




There are three main types of stress that occur when two gears come into contact:

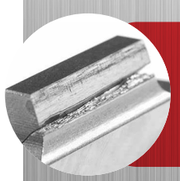
Tooth Root

Defect: Tooth root breakage.
Stress types: Pressure, Bending, Shear.



Tooth Flank

Close to surface (<100µm)
Defect: Pitting, Micropitting, Scuffing.
Stress types: Friction, kinematics, Pressure.

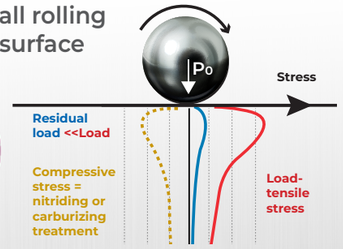


Subsurface and Core

Contact fatigue
Defect: Tooth flank breakage.
Stress types: Bending.

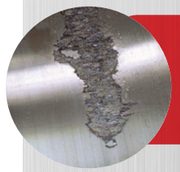
Bearing application

Example of ball rolling on a bearing surface



Close to surface (<100µm)

Defect: Micropitting, Scuffing and wear.
Stress types: contact pressure friction and sliding.



Sub-Surface

Defect: Pitting, fatigue failure.
Stress types: Hertz Pressure.

The loading of a ball in contact with a raceway provides tensile stresses that can be compensated by increasing the surface hardness and introducing of the compressive stresses.

Metallurgical solution

To answer to the increase of the Hertz pressure / applied bending stress, rolling contact fatigue and higher operating temperatures, there is a need to use treatment solutions that can push-back these stresses.

Different material strategies:

- Carburizing using high tempering steel
- Steel grade optimized for deep nitriding
- Duplex hardening alternative (carburizing + nitriding for surface distress)

Next-generation steels for transmissions

AD65N™ - Nitriding steel

AD65N is a new 3% Chromium nitriding steel with slightly adjusted chemical composition in comparison with the common 33CrMoV12-9 steel and an excellent compromise between strenght and toughness.

Typical Mechanical properties

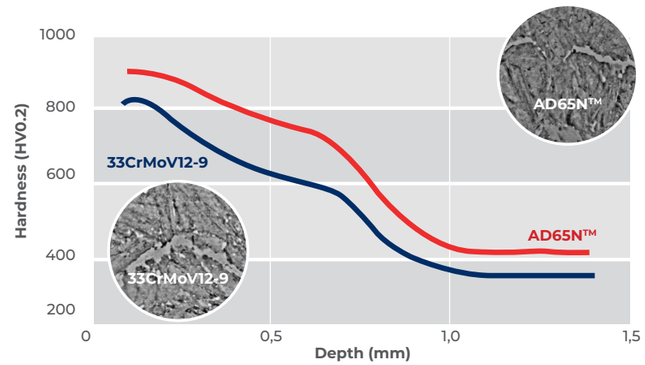
	Tempering (°C)	YS0.2 Core (MPa)	UTS Core (MPa)	K1c Core (MPa.Vm)	Hardness surface (HV10)	Case depth Hvcore + 100 (mm)
GKH™ (33CrMoV12-9)	600°C	1060	1250	180	850	0.75
GKP® (32CrMoNiV5)	600°C	1280	1430	80	900	0.90
AD65N™ (30CrMoV13-15)	600°C	1280	1480	100	920	0.85

Different melting route (with or without remelting process) is possible depending on the desired final mechanical and fatigue properties.

Nitriding thermochemical treatment

Capable of very deep nitriding with reduced time compared to current nitriding steels: due to the nature of the very fine microstructure and the precipitates, the kinetic of nitriding is better than standard nitriding steel.

The surface hardness and core strength are greater than those of current nitriding grades.



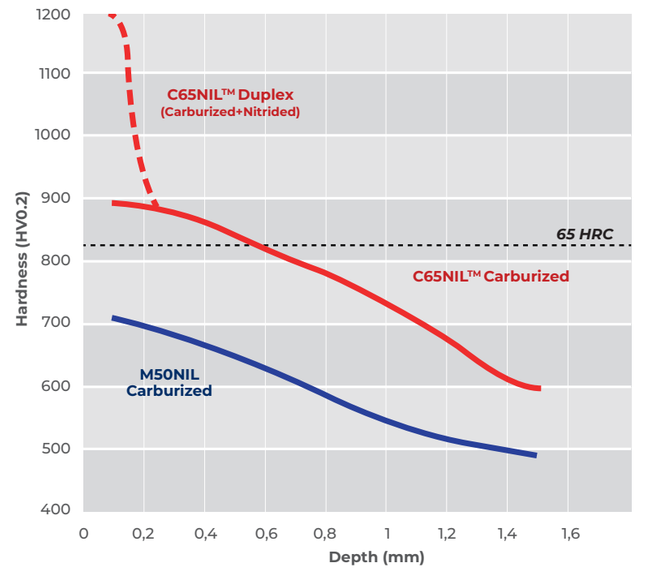
Comparison of hardness profil between AD65N™ and 33CrMoV12-9 grade after deep nitriding (Nitriding temperature: ≈ 550°C – Duration : ≈ 120 hours.)

C65NiL™ - New carburizing steel for gears & bearings

A new carburizing grade the C65NIL™ has been developed by Aubert&Duval with an original metallurgical design based on M50NIL alloy, with a higher content of Molybdenum, Vanadium and Cobalt to increase surface hardness.

C65NiL™ is in the low Co family (<8%) and makes it possible to achieve a hardness level of more than 825 HV (about 65 HRC) after thermochemical and heat treatments with a toughness level comparable to the reference grade M50NIL.

	UTS Core (MPa)	K1c Core (MPa√m)	CHARPY V-NOTCH KV (Joules)	Surface Hardness after Carb. HV10
M50NIL	1400	65	30	> 720
C65NIL™	1600	40	10	> 850



Comparison of hardness profil between M50NIL and C65NIL™ grade after carburizing.

OUR GRADES FOR TRANSMISSIONS

AD GRADES	EUROPEAN STANDARD	USA	AIR	WR	AMS	Numerical	MELTING PROCESS			CHEMICAL COMPOSITION						HEAT TREATMENT see key below	TYPICAL MECHANICAL PROPERTIES					APPLICATIONS
							AIR	AIR + REMELTING	VIM + VAR	C	Ni	Cr	Mo	V	Others		UTS (N/mm²)	0.2% YS (N/mm²)	El (%)	KCU (J/cm²)	KV (J)	
STEELS FOR CARBURIZING																						
FADC	10NiCrMo13-5	UNS:G93106 AISI:9310					x	x	X	0.1	3.25	1.2	0.1			T + F + Rv 150°C	1150		14		140	Various heavily stressed carburized and non carburized mechanical parts. Parts for the aerospace industry.
FADH	14NiCrMo13-4	UNS: K43214	16NCD13	1.6657 1.6658	6547 6548 6549	1.6657	x	x	x	0.16	3.2	1	0.25			T + F + Rv 150°C	1350	1000	14		140	Transmission parts such as gears, shafts, actuators and various wear-resistant parts exposed to fatigue for aerospace industry, motor sport and mechanical parts.
FADS	16NiCrMo16-5						x	x	x	0.16	4.25	1.2	0.2			T + F + Rv 150°C	1450		12		90	Various carburized and non carburized mechanical parts subjected to high stresses. Parts for the aerospace industry.
FDG	20NiCrMo13-4	UNS: K41910			6492 6493	1.666	x	x	x	0.2	3.2	1	0.5			T + F + Rv 150°C Tgaz + F + Rv 150°C	1450 1350	1100 1000	13 13		130 110	Transmission parts such as gears, shafts, actuators and various wear-resistant parts exposed to fatigue for aerospace industry, motor sport and mechanical parts.
FND™	15NiMoSiCr10	UNS: K51570			6494 6495		x	x	x	0.15	2.5	1	2		Si:1.10	T + F + Rv 300°C Tgaz + F + Rv 300°C	1400 1350	1120 1030	13 13		120 110	Injector, transmission parts as gears, shafts, actuators and various wear-resistant parts exposed to fatigue and in-use temperature up to 250°C.
50NILYW	13MoCrNiV42-16-14	UNS: K91231 M50NiL			6278	B61			X	0.13	3.4	4.15	4.25	0.25		T + F + Rv 550°C	1400	1200	13			High performance carburizing steel grade for parts requiring an excellent combination of rolling contact fatigue and in-use temperature up to 400°C.
CX13VD	X12CrNiMoV12-3	UNS: S64152			5719		X	X		0.12	2.5	12	1.6	0.3		T + F + Rv 250°C	1350	1000	13		130	Aerospace industry and industrial applications for: Ball screws, blade propellers, gears, etc.
819AW	35NiCrMo16		E-35NCD16H					X		0.38	4	1.75	0.5			T + F + Rv 200°C T + Rv 650°C	1900 1050	1500 900	10 18	50 110		Aerospace parts exposed to high stresses. Various heavily stressed mechanical parts.
NC310YW	40SiNiCrMoV10	UNS : K51570			6499				X	0.4	1.75	0.85	0.4	0.2	Si:2.70	T + F + 2xRv 300 °C	2150	1790	9			Various heavily stressed mechanical parts. Carburising possible (torsion bars, gears, transmission shafts).
C65NiL™ YW	X20MoCoCr-NiV5-5-4-3-2								X	0.2	3	4	5	2	Co:5		1680	1350	15		8	High performance carburizing steel grade for parts requiring an excellent combination of rolling contact fatigue and in-use temperature up to 400°C.
STEELS FOR NITRIDING																						
GKH®	33CrMoV12-9	UNS: K24340	32CDV13		6481		X	X	X	0.3		3	1	0.2		T + Rv 600°C T + Rv 640°C	1250 1080	1060 900	15 19		130 170	Components (particularly aerospace parts) requiring very good mechanical properties in the core (surface hardness approximately 850 Vickers).
GKP®YW	32CrMoNiV5	UNS: K23280			6497 6498				X	0.3	0.8	1.4	1.2	0.3		T + Rv 600°C T + Rv 640°C	1430 1250	1280 1075	14 16		50 80	Parts which must be highly stable (gears, spindles, crankshafts, precision parts, aerospace parts).
GH4	40CrMoV13-9		40CDV12			1.8523	X	X	X	0.4		3	1	0.2		T + Rv 200°C T + Rv 600°C	1950 1400	1450 1150	10 13	60 65		Parts for the aerospace industry exposed to high stresses (mechanical strength of the order of 1400 N/mm²).
GK3	31CrMo12/32CrMo12		30CD12	1.8564		1.1815/ 1.7361	X	X	X	0.3		3	0.4			T + Rv 625°C	1000	850	18	150		Gears, spindles, machine tool components, various mechanical parts
AD65N™	30CrMoV13-15						X	X	X	0.3	<0.1	3.2	1.5	0.45	Mn:0.2	T + Rv 600°C T + Rv 640°C	1480 1320	1280 1150	16 17		55 210	High performance Nitiriding steel. Components (particularly aerospace parts) requiring very good mechanical properties in the core and thermal resistance (surface hardness approximately 900 Vickers).
THROUGH HARDENING STEELS																						
RA50YW	80MoCrV42-16	UNS: T11350 AISI: M50	E-80DCV40	1.3551 1.3552	6491				X	0.83		4.15	4.25	1		T + 3xRv 550°C	hard-ness: 60 / 63 HRC					Aerospace bearings exposed to high stresses.
XD15NW®	X40CrMoVN16-2	UNS: S42025		1.4123	5925	1.4123		X		0.42		16	1.8	0.35	N:0.2	T + F + Rv 180°C	hard-ness: 59 HRC					Bearings, ball screws, valve seats, guide collars.
XD16N	X50CrSiMnVN16-1	UNS: S42716			5926		X			0.5		16		0.3	Ti: 0.3 V:2 Si:3	T + F + Rv 180°C	hard-ness: 58 HRC					Bearings, ball-screws for industrial applications.
FDMA	30NiCrMo16		30NCD16				X	X		0.3	3.5	1.2	0.45			T + Rv 200°C T + Rv 625°C	1750 1000	1250 900	12 19	70 140		Parts requiring excellent fatigue and impact resistance.
NC40M	41NiCrMo7-3-2	UNS: G43406 AISI / SAE: E4340			6409 6414	1.6563	X	X		0.4	1.8	0.8	0.25			T + Rv 600°C	1100	950	17	100		Parts requiring excellent fatigue resistance (shafts, gears, various safety-critical mechanical parts).
NC40S	40NiSiCrMo7	AISI: 300M			6417 6419			X		0.4	1.8	0.85	0.4		Si: 1.6	T + 2xRv 300°C T + Rv 600°C	2050 1450	1700 1300	12 14	50 60		Shafts, gears, various safety-critical mechanical parts, various heavily stressed aerospace mechanical parts.

KEY TO HEAT TREATMENT SYMBOLS	
Sub-zero treatment	F
Quenched and tempered	T+Rv
Thermo-mechanical treatment	T

The list of products in the table is not exhaustive, please consult us for other materials.

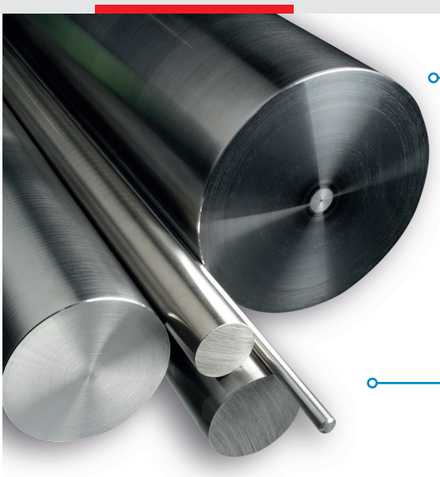
Power in motion :
Steels that drive performance

Since 1907 Aubert & Duval has been a recognized leader in the development of high-performance steels, working hand in hand with its clients from the earliest stages of material selection. We specialize in designing and manufacturing tailor-made steel grades that meet the most demanding requirements in sectors where reliability, precision and performance are non-negotiable.

A transmission system is a heart of mechanical energy management and have two functions: transferring mechanical power to wherever it is required and transmitting the motion from one component to another. To achieve this objective, even under the most severe conditions, it is essential that the components are produced from the finest materials available.

Aubert & Duval has a proven track record in the development of transmission steels, dating back to 1970 when the GKH™ grade was introduced. Since then, we have worked with our customers to invent new alloys, such as AD65N™ and C65NiL™ which will meet the needs of next generation transmissions systems.

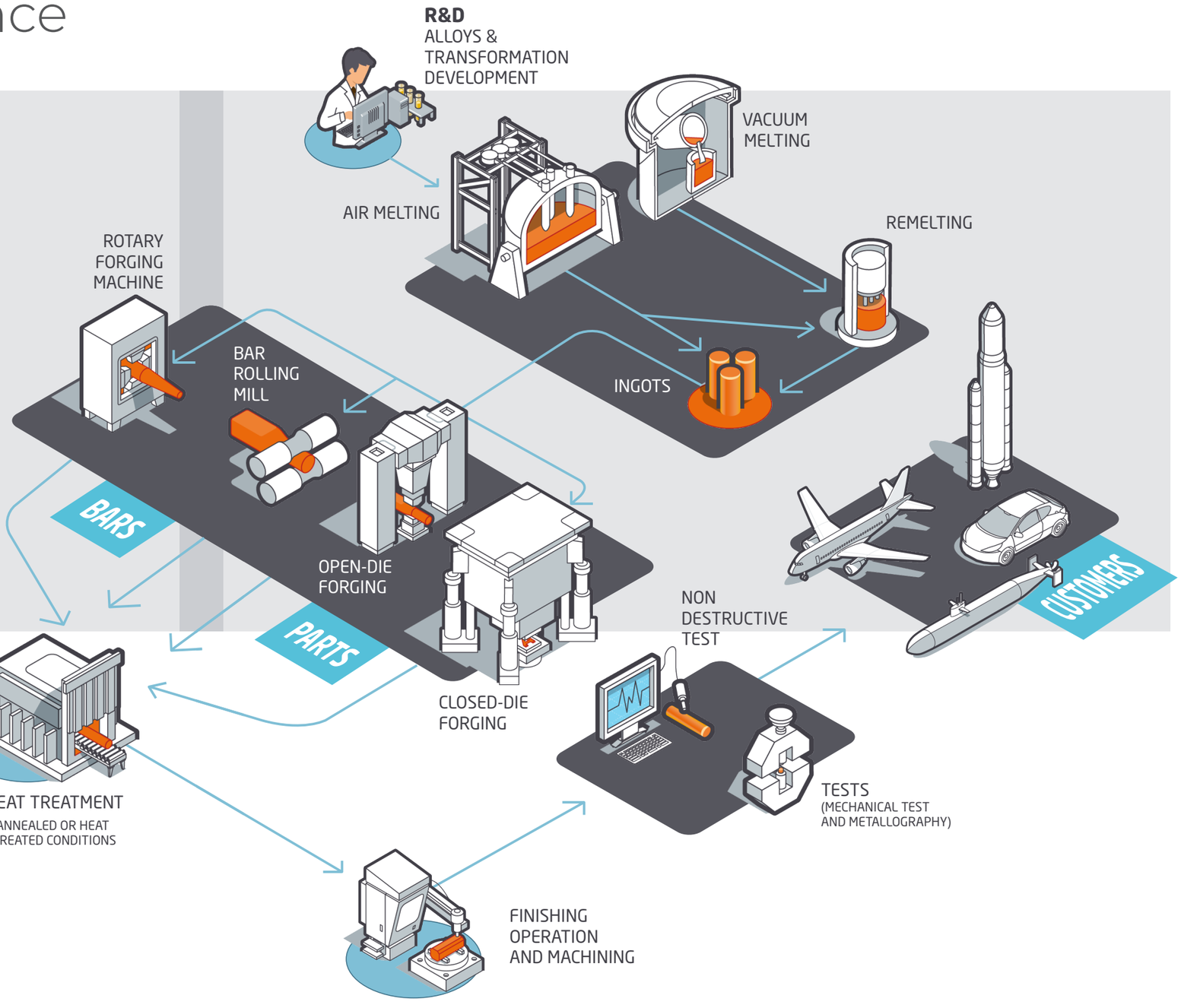
Our aim is to achieve excellence in each of your components—because performance starts with the right material.



BEARINGS

GEARS

BALL SCREW



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