

# Innovative stainless steel applications in transport vehicles - INSAPTRANS

## The landscape of 'classic' and 'alternative' stainless steels grades

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**INSAPTRANS**

## Euro Inox is the European association for stainless steel

- European stainless steel producers
- National stainless steel development associations
- Development associations of the alloying element industries

## Main activities

- Initiation of technical and market R&D activities
- Technical publications (print, CD, Internet)
- Conferences and seminars



## Content

1. Introduction – Stainless steel families
2. Material selection
  - Austenitic CrNi
  - Austenitic CrMn
  - Ferritic
  - Duplex
3. Summary – future prospects

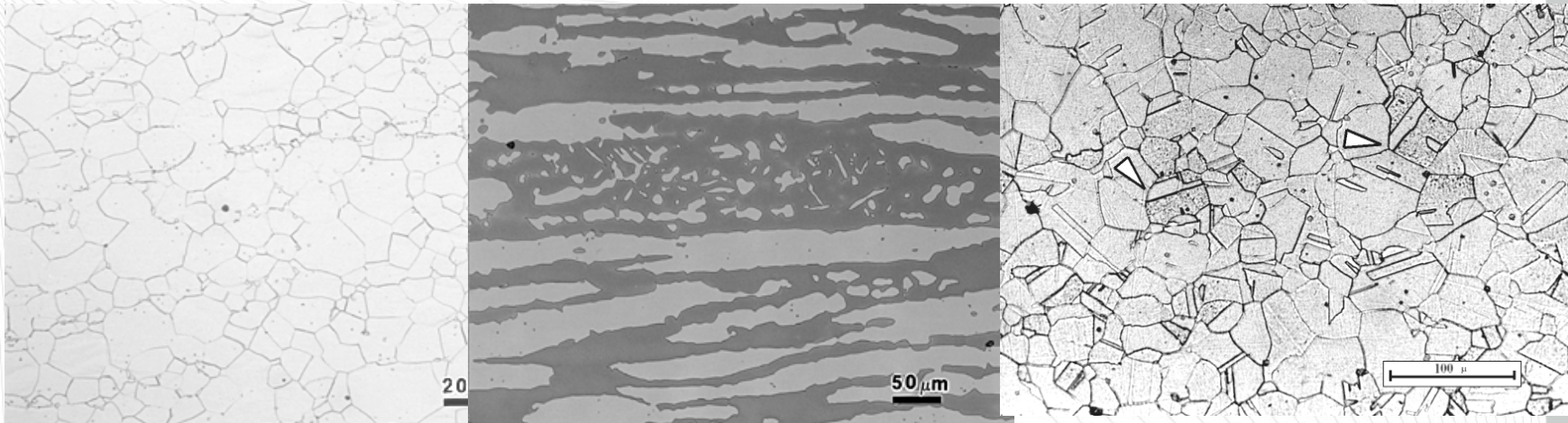


Source: Bombardier, 2007



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- The first industrial manufacture attributed to Harry Brearley (1913)



- 0 % Ni  
Ferritic

- 5 % Ni  
Duplex

- > 8 % Ni  
Austenitic

The properties can be modelled by alloying

- Cr content provides corrosion resistance
- Ni content affects the microstructure

Updated information on application data for various stainless steel grades is provided

- Austenitic steel grades
- Ferritic steel grades

CrNi  
1.4301  
304sp  
1.4318

CrMn  
16-7Mn

Cr  
1.4003



The workhorse of the industry is austenitic stainless steel 18/8



Source: Centro Inox, Italy

1.4301 / 1.4307  
(304 / 304L)

## Strengths

- Corrosion resistance
- Formability
- Weldability
- Versatility
- "Forgiveness"

## Weaknesses

- Price volatility!
- In the project also 304sp tested

**Cr 18 %, Ni  $\geq$  8%**



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1.4318 / 301 LN

## Benefits

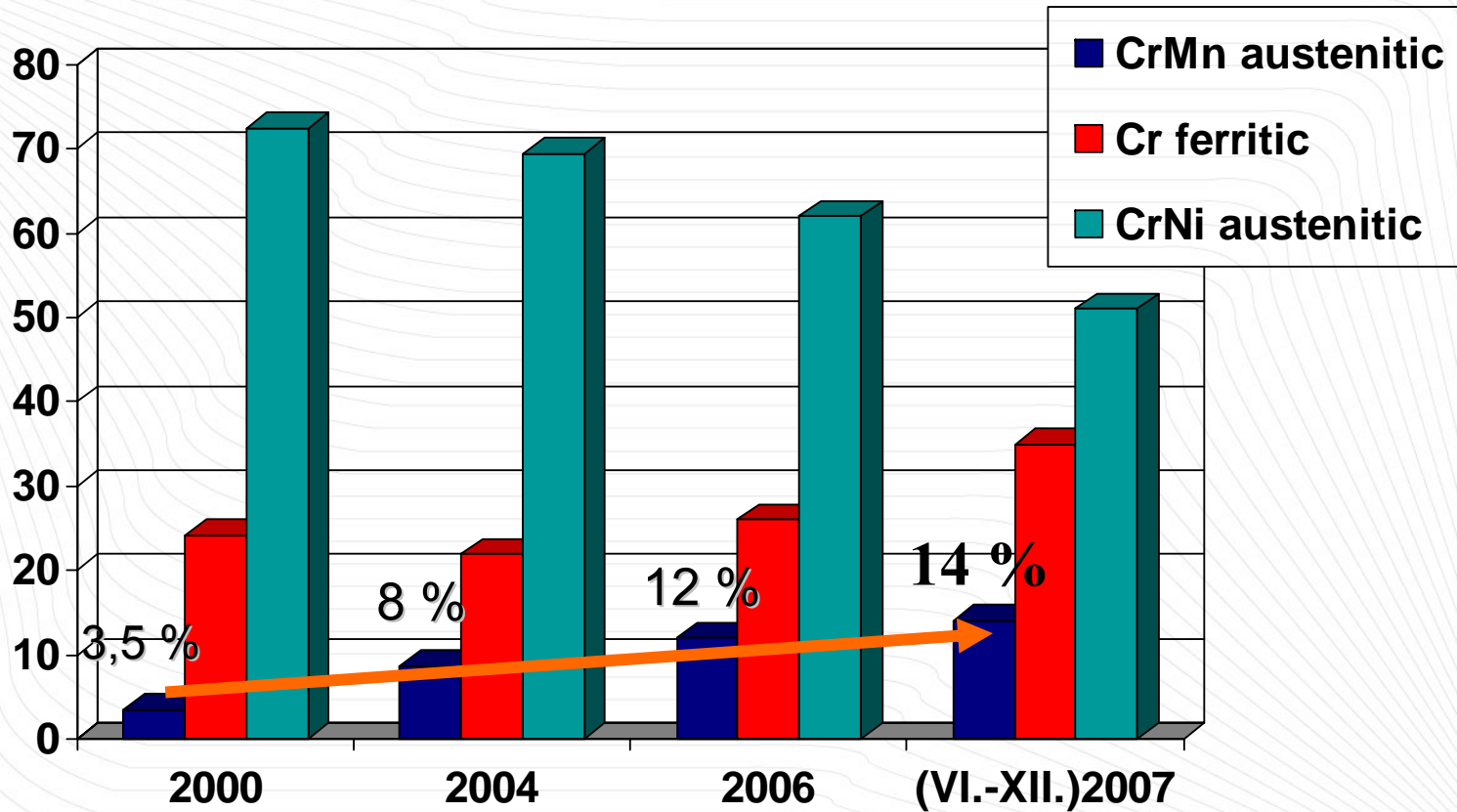
- High strength-to-ductility ratio
- High work hardening rate
- Corrosion resistance
- High mechanical properties

1.4311 / 304 LN

**Cr 18 %, Ni  $\geq$  6% + N**



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Price increase of raw materials triggered the growth of low nickel grades

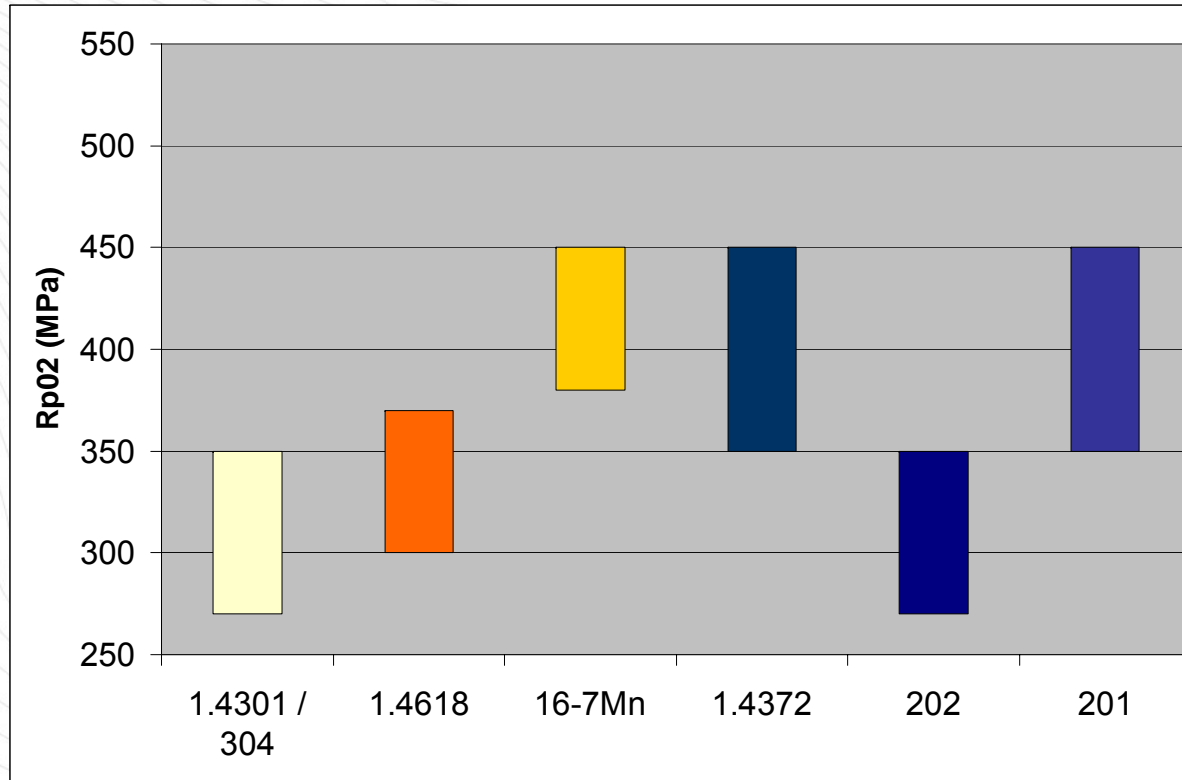
		Chemical composition (% by mass)					
Steel grade		C	Mn	Cr	Ni	N	Cu
1.4301/ 304	EN 10088-2	max.0.07	max.2.0	17.5-19.5	8.0-10.5	max.0.11	-
1.4318/ 304LN	EN 10088-2	max. 0.03	max.2.0	16.5-18.5	6.0-8.0	0.10-0.20	-
16-7Mn	Tested material	0.05	7.7	16.5	1.60	0.19	2.9
1.4618/ 202Cu	NEW	max.0.10	5.5-9.5	16.5-18.5	4.5-5.5	max.0.15	1.0-2.5

CrMn grades - Comparable in initial costs to 1.4301 it could be a lower cost solution



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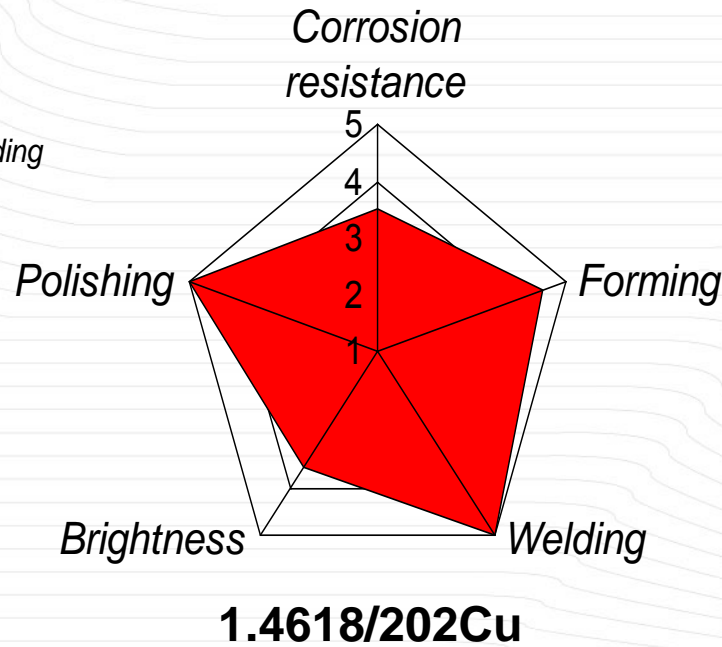
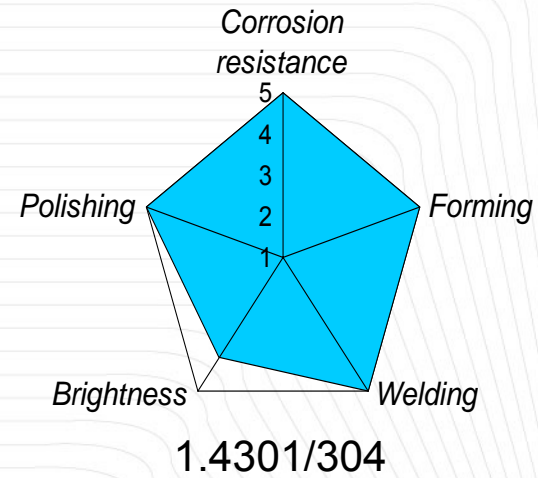
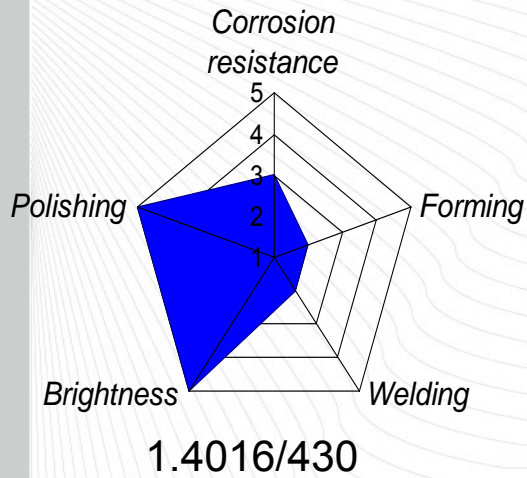
The yield strength is in approximately the same range.



Source: ArcelorMittal Stainless



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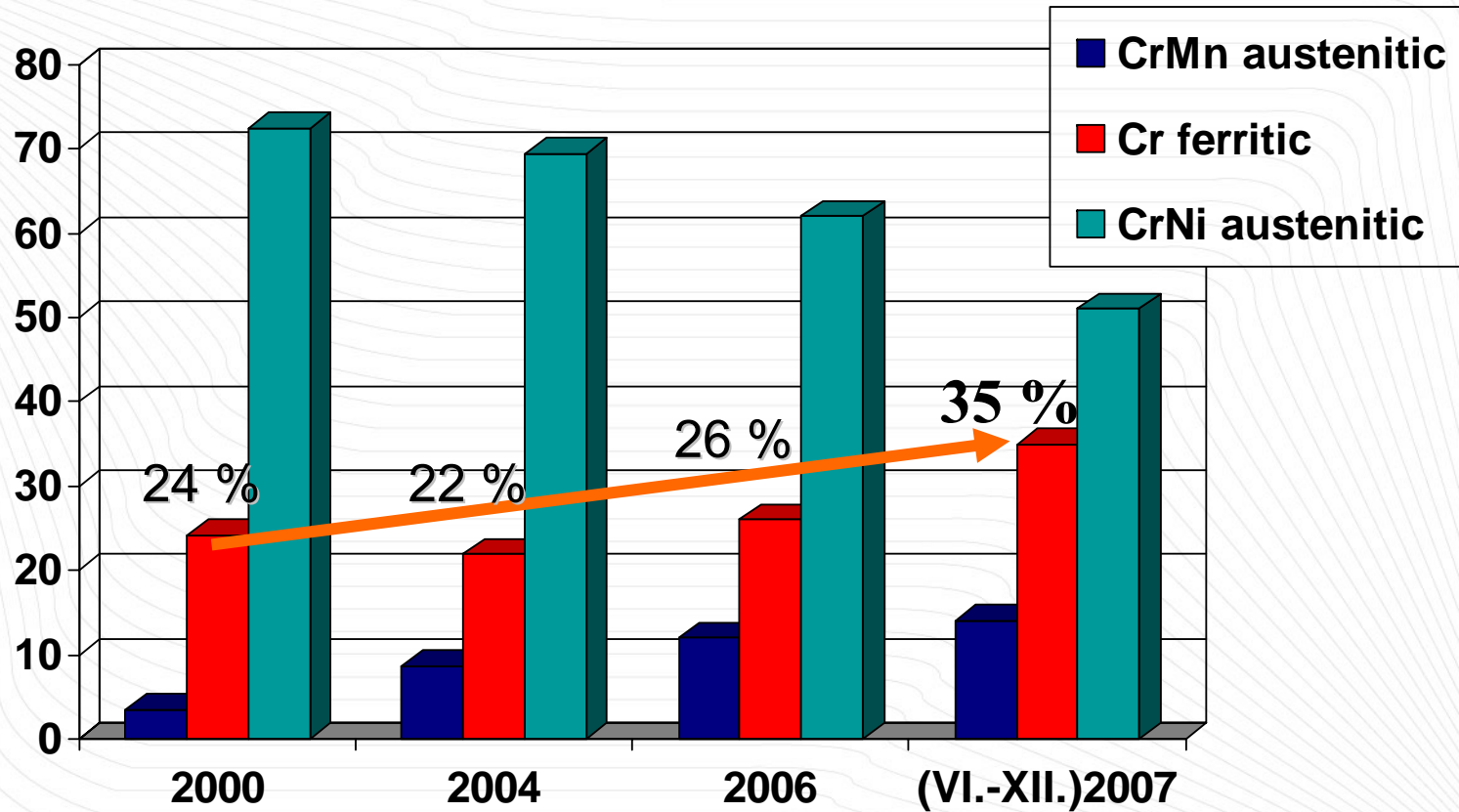


- 1 poor
- 2 sufficient
- 3 satisfactory
- 4 good
- 5 excellent

Source: TKN



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The share of ferritic stainless steels increased substantially

1.4003

## Benefits

- Corrosion resistance much better than mild steel
- Good durability
- Low maintenance costs
- Painting and coating in some applications – corporate colours
- Lower initial costs



Source: Centro Inox, Italy

Painted stainless steel skin – double decker and tram

**Cr 11 %**



Source: T. Pauly



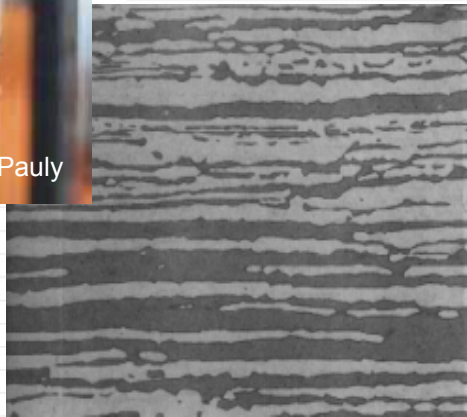
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		Chemical composition (% by mass)					
Steel grade		C	Cr	Mo	Ni	Ti	Nb
1.4003	EN 10088-2	max.0,03	10,5-12,5	-	0,30-1,00	-	-
1.4016/ 430	EN 10088-2	max.0,08	16,0-18,0	-	-	-	-
<b>1.4520/ 439</b>	EN 10088-2	max.0,025	16,0-18,0	-	-	0,30-0,60	-
<b>1.4509/ 441</b>	EN 10088-2	max.0,030	17,5-18,5	-	-	0,10-0,60	(3xC+0,30) max. 1,00
<b>1.4521/ 444</b>	EN 10088-2	max.0,025	17,0-20,0	1,8-2,5	-	(4x(C+N)+0,15) max. 0,80	





Source: T. Pauly



1.4462 / 2205

1.4362 / 2304

## Benefits

- High corrosion resistance – SCC and pitting corrosion
- High mechanical properties
- Structural material
- Weight saving

■ **Cr 22%, Ni 5%, Mo 3%, N**



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Duplex stainless steels were not part of the project, but could be used in many applications

		Chemical composition ( % by mass)					
Steel grade		C	Mn	Cr	Ni	N	Mo
1.4301 /304	EN 10088-2	max.0,07	max.2,0	17,5-19,5	8,0-10,5	max.0,11	-
<b>1.4462</b> <b>(2205)</b>	EN 10088-2	max.0,03	max.2,0	21,0-23,0	4,5-6,5	0,10-0,22	2,5-3,5
<b>1.4362</b> <b>(2304)</b>	EN 10088-2	max.0,03	max.2,0	21,0-23,0	5,5-6,9	0,05-0,20	0,1-0,6

**Corrosion resistance**  
**Mechanical properties ↑**



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- Selected steel grades from all main stainless steel families are suitable material for bus and rail applications
- Future prospects
  - Austenitics: work-hardened grades
  - Ferritics: lower cost solution
  - Duplex: weight saving



*Thank you for your attention*

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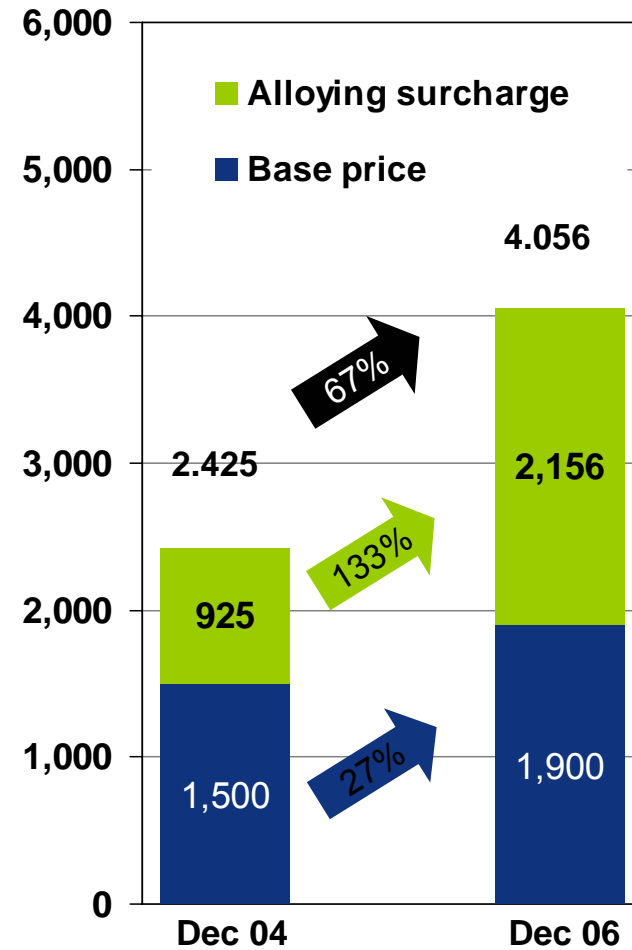
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# The contribution of nickel to the price of final product increased substantially

## Raw materials – growth rate

- Nickel Feb 02 - Feb 07 +698 %
- Chromium Feb 02 - Feb 07 +332 %
- Molibdenum Feb 02 - Feb 05 +1096 %
- Scrap Feb 02 - Oct 04 +186 %

Source: TKN



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