

400系不銹鋼金屬粉型包藥銲線研製

Development of 400 series Stainless Steel Metal Cored Wires



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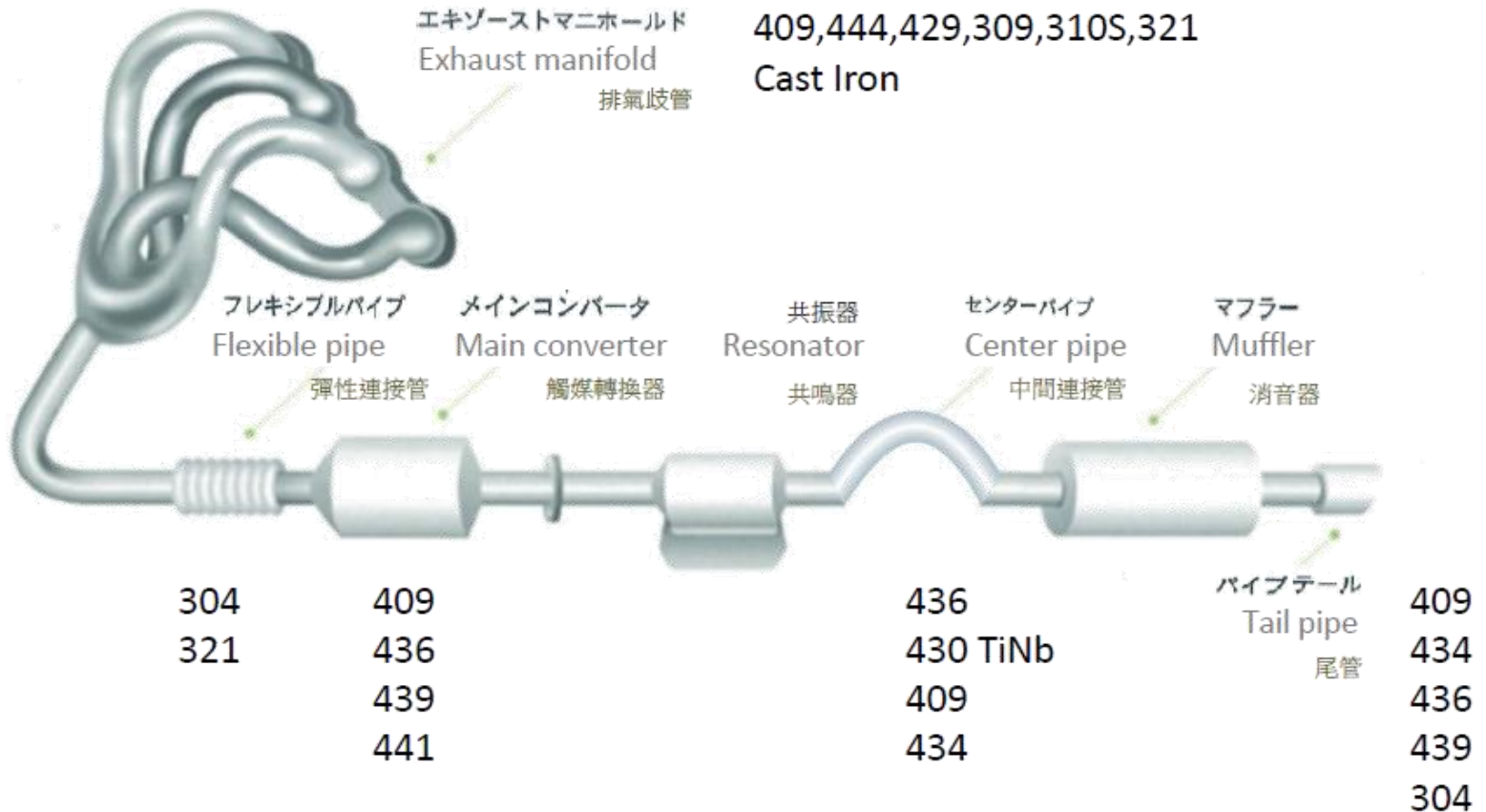
Applications & Features

- 400 series stainless steel metal cored wires have specifically formulated for use in the welding of **automotive exhaust systems** and **mufflers**.
- They benefit from being **spatter free** and **without slag formation** when used in conjunction with **argon** or **argon-oxygen mixed shielding gas**.
- They also have an excellent **deposition rate** and **corrosion resistance**.

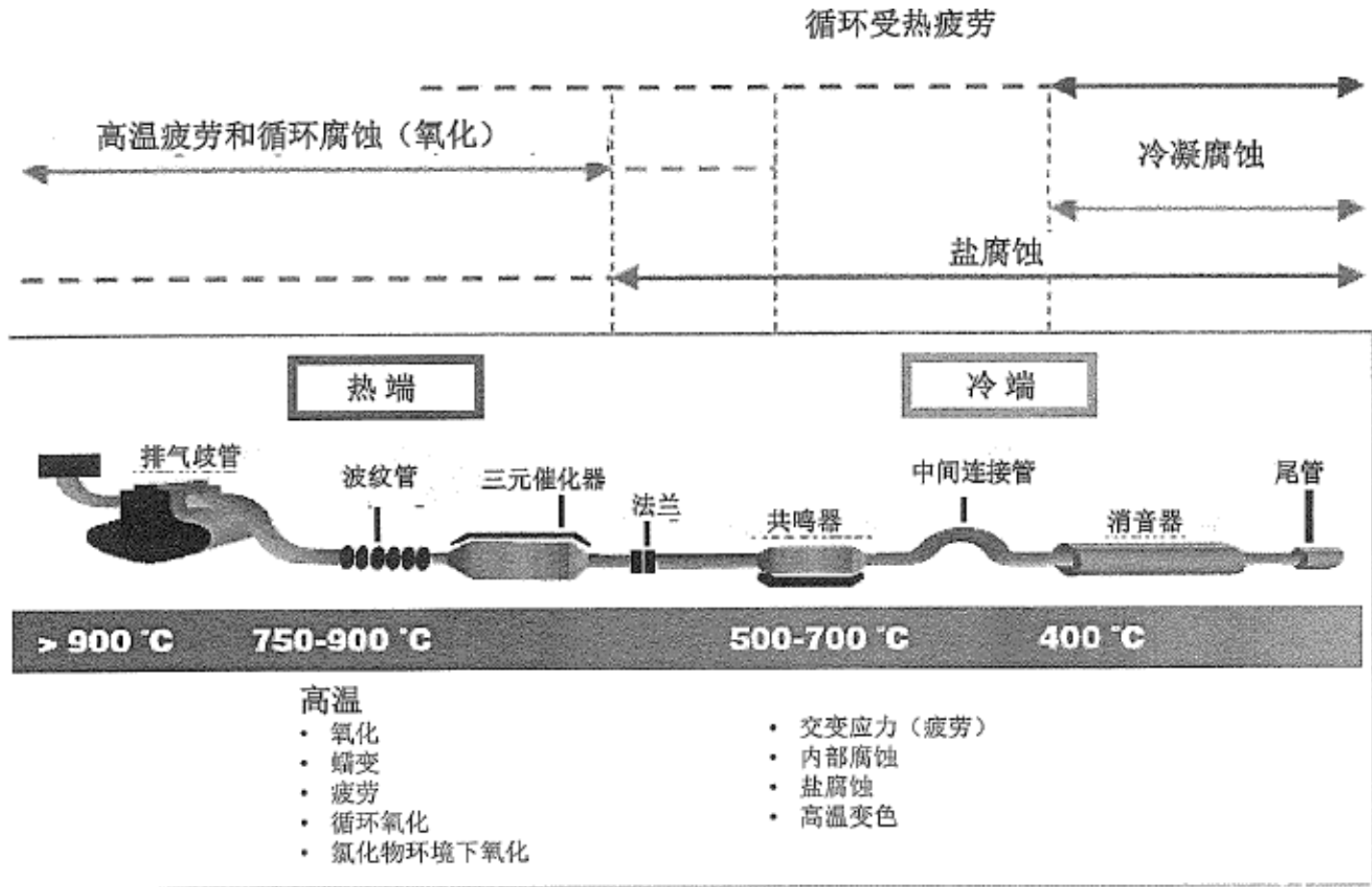


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Exhaust system- Base metal



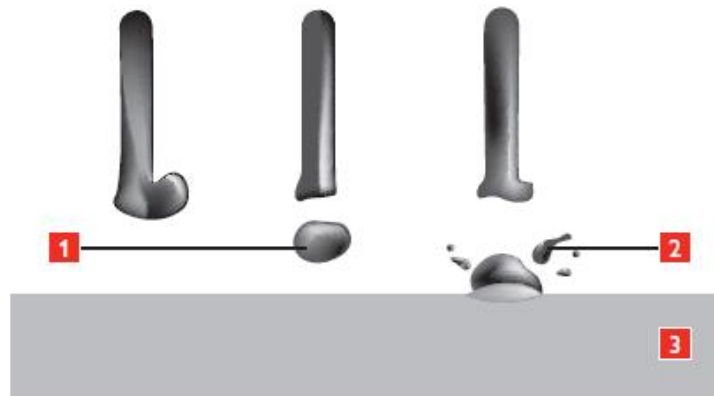
Exhaust system-Environment



Advantages of Metal Cored Wires

- Higher ***burn-through resistance***
- Good ***root-gap-bridging ability***
- Superior ***crack resistance***
- Faster ***travel speed***
- Improved ***arc stability***
- Higher flexibility of ***alloying composition***
- Good ***wetting behavior***
- ***No slag, low spatter and less clean up***
- Much ***wider welding parameters***

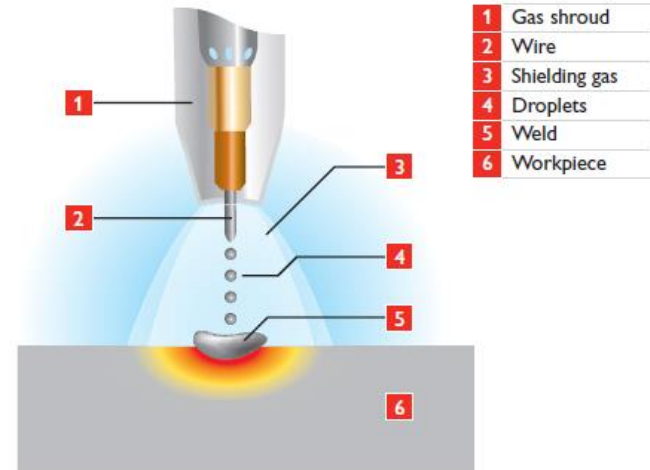
Characteristics- Solid Wire & Metal Cored Wire



Schematic of Globular Transfer

Metal cored wire

Solid wire



Schematic of Spray Transfer



Motive

- To replace **solid wire**
 - **Lower cost**
 - **Better spatter performance**
- To optimize **weldability**
 - **Spatter performance**
 - **Bead wettability**
 - **Welding parameter range**
 - **Burn-through resistance**
- To improve **mechanical properties**

Chemical composition

| 409Ti | C | Si | Mn | Cr | Ti | N |
|-------|------|-----|-----|-------|------|-------|
| A | 0.03 | 0.5 | 0.4 | 11.71 | 1.03 | 0.037 |
| B | 0.04 | 0.6 | 0.4 | 10.99 | 1.06 | 0.020 |
| C | 0.04 | 0.3 | 0.6 | 11.52 | 1.04 | 0.010 |

| 439Ti | C | Si | Mn | Cr | Ti | N |
|-------|------|-----|-----|-------|------|-------|
| A | 0.05 | 0.4 | 0.3 | 17.81 | 0.93 | 0.038 |
| B | 0.02 | 0.3 | 0.7 | 17.45 | 0.71 | 0.018 |
| C | 0.03 | 0.5 | 0.6 | 18.07 | 0.59 | 0.015 |

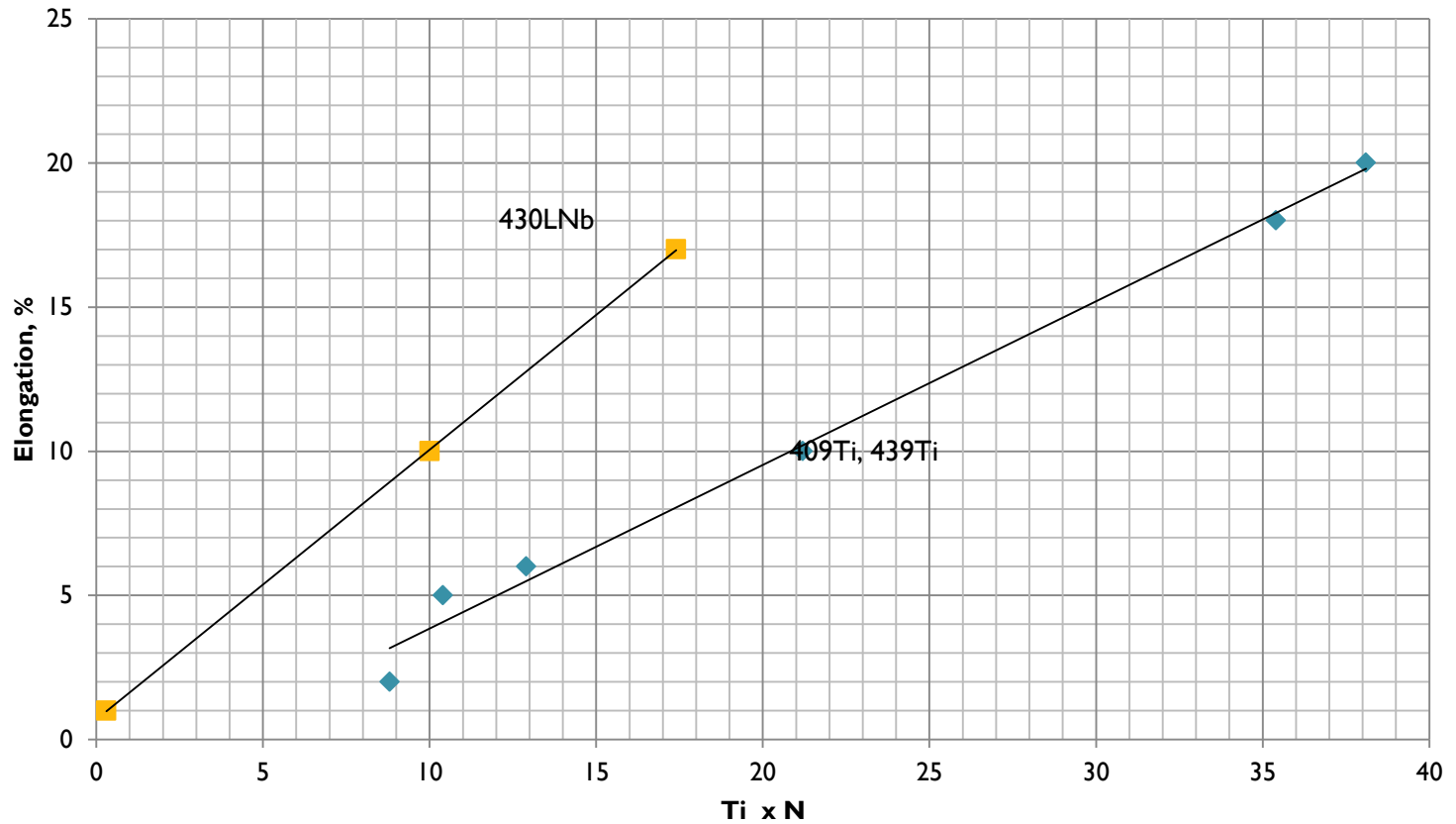
| 430LNb | C | Si | Mn | Cr | Nb | Ti | N |
|--------|------|-----|-----|-------|------|------|-------|
| A | 0.04 | 0.5 | 0.3 | 17.34 | 0.71 | 0.45 | 0.039 |
| B | 0.06 | 0.2 | 0.2 | 17.34 | 0.65 | 0.32 | 0.031 |
| C | 0.03 | 0.6 | 0.7 | 17.52 | 0.36 | 0.02 | 0.018 |

Mechanical properties

| | TS(MPa) | YS(MPa) | EL(%) | Hardness(HRB) |
|----------|---------|---------|-------|---------------|
| 409Ti-A | 535 | 423 | 20 | 101.2 |
| 409Ti-B | 490 | 432 | 10 | 97.2 |
| 409Ti-C | 432 | 381 | 5 | 87.9 |
| <hr/> | | | | |
| 439Ti-A | 553 | 448 | 18 | 103.3 |
| 439Ti-B | 417 | 396 | 6 | 98.8 |
| 439Ti-C | 366 | 356 | 2 | 101.3 |
| <hr/> | | | | |
| 430LNb-A | 616 | 506 | 17 | 102.7 |
| 430LNb-B | 541 | 453 | 10 | 96.5 |
| 430LNb-C | 345 | 345 | 0 | 102.4 |

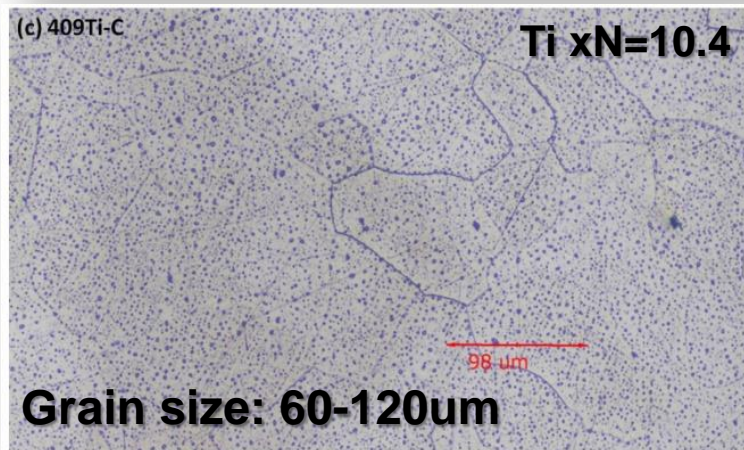
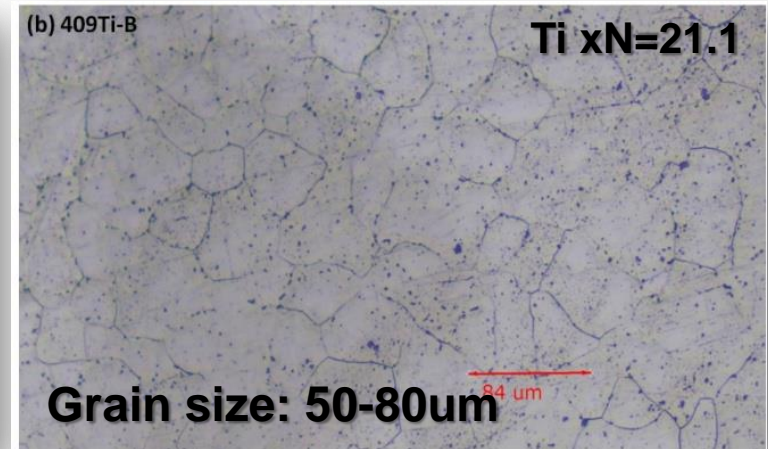
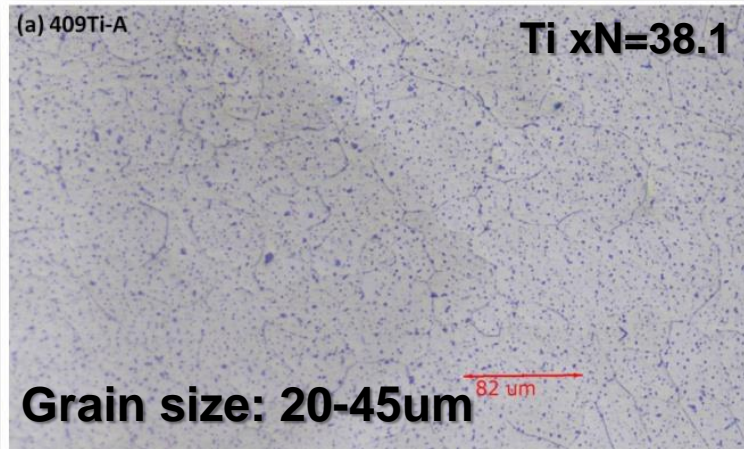


Elongation v.s $Ti \times N$



Ti x N \uparrow Elongation \uparrow Grain size?

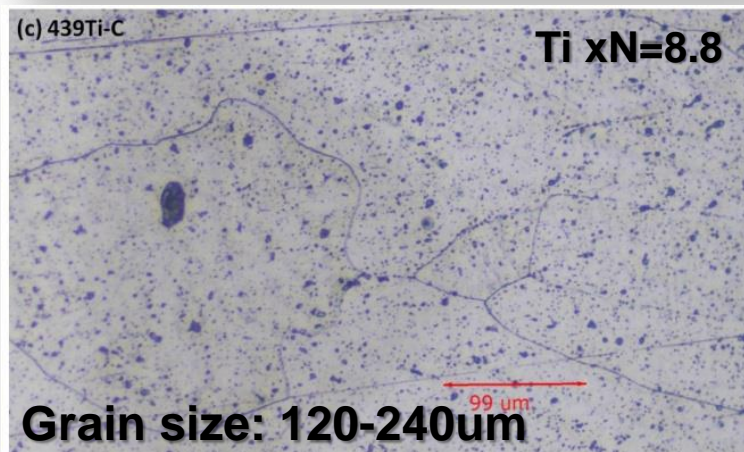
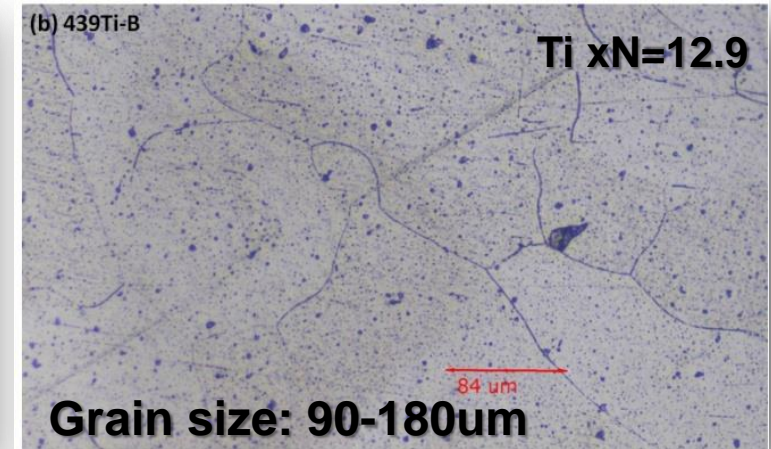
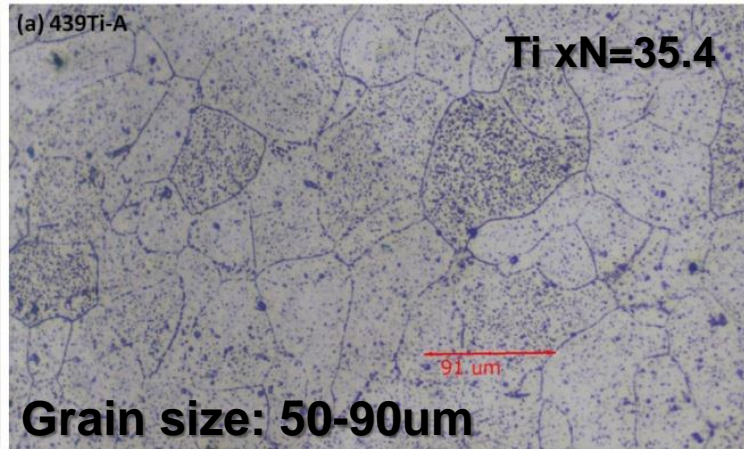
Microstructure-409Ti



Ti x N 

Grain size 

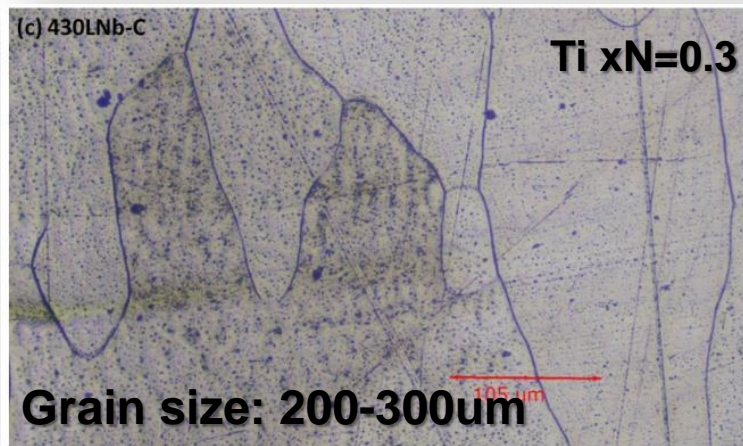
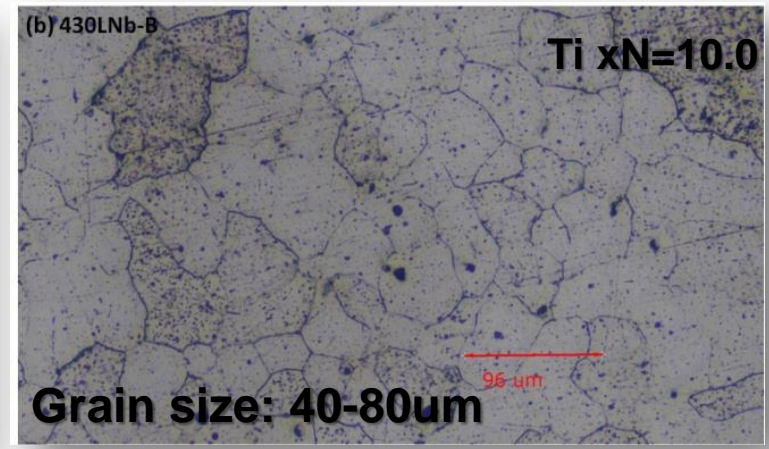
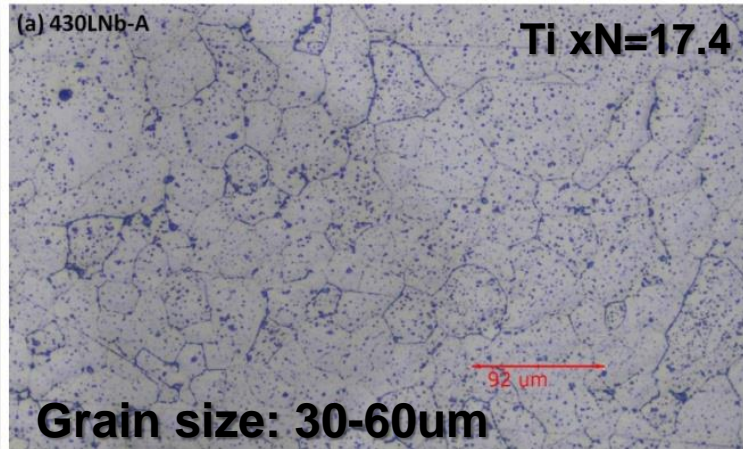
Microstructure-439Ti



Ti x N ↑

Grain size ↓

Microstructure-430LNb



Ti x N \uparrow Grain size \downarrow

Ti N



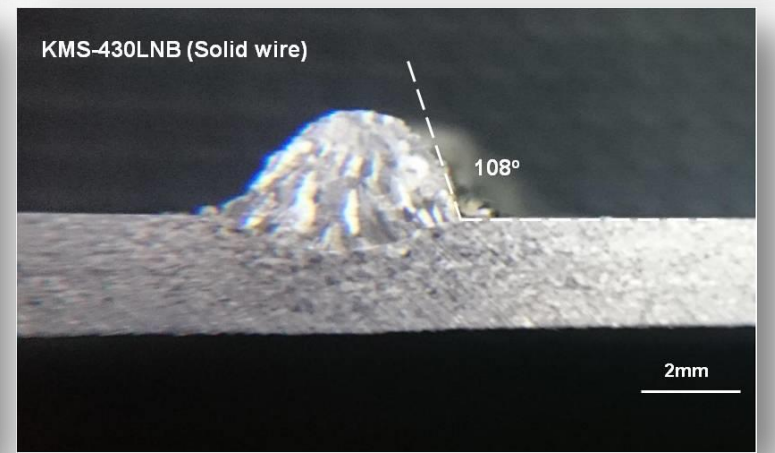
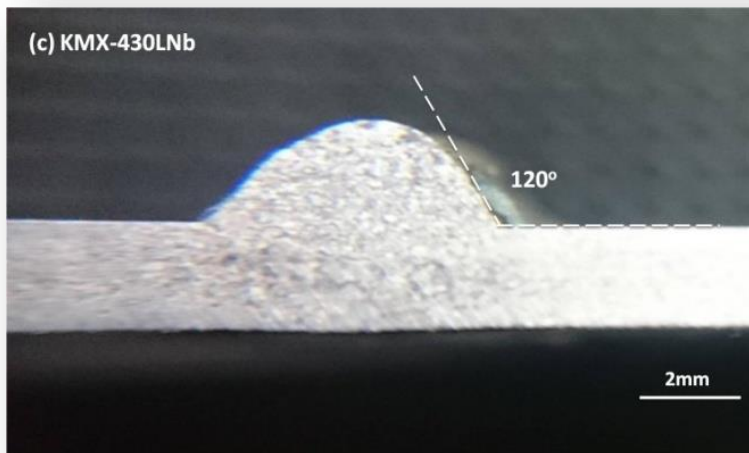
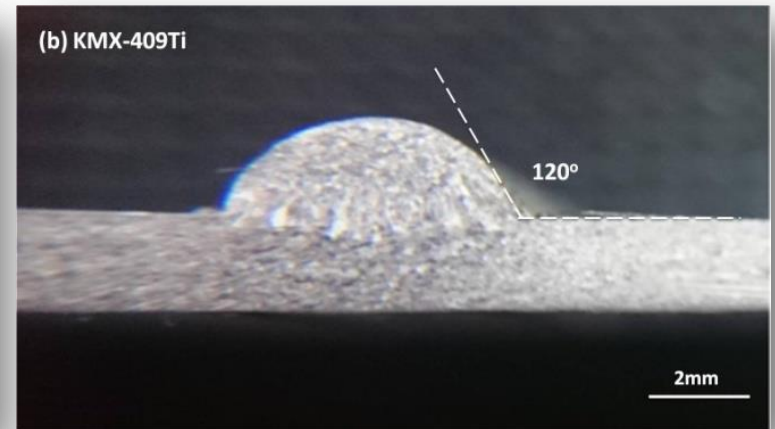
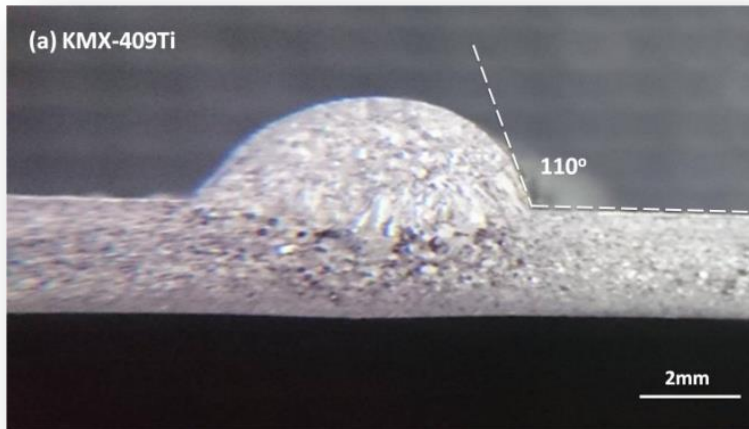
Heterogeneous Nucleation



Grain Refinement

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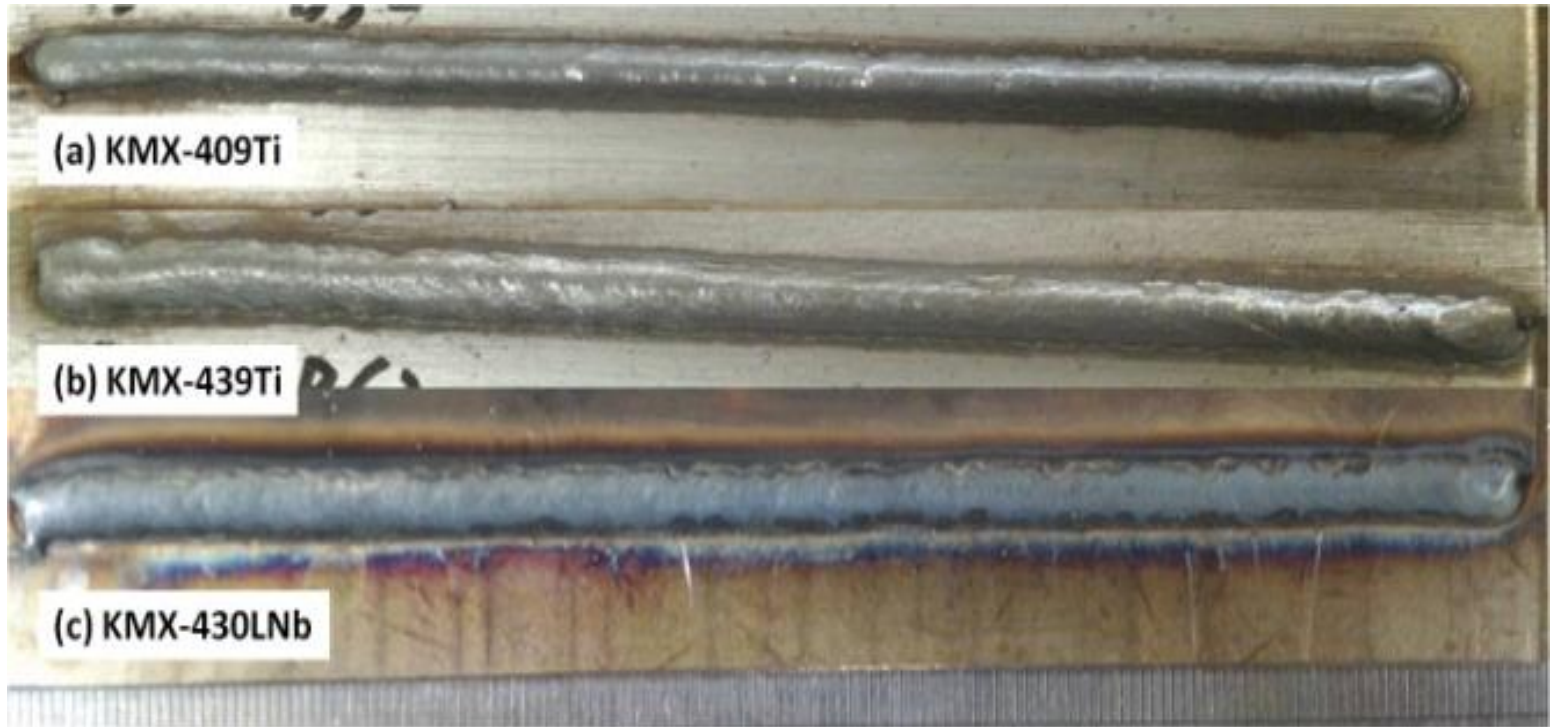
Bead wettability



Current: 130A Voltage:13V Shielding Gas: 98%Ar+2%O₂

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Spatter performance



Spatter free!

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Conclusion

- KT 400 series metal cored wires have **excellent mechanical properties** due to **finer microstructure**.
- Finer microstructure results from **the increase of Ti x N**.
- KT 400 series metal cored wires have **better bead wettability** due to **moderate flux addition**
- KT 400 series metal cored wires have **excellent spatter performance** due to **arc- stablizer addition**