KOBELCO

GLOBAL MANUFACTURING BASES AND OFFICES

ASIA

JAPAN:
KOBE STEEL, LTD., Welding Business
Global Operations and Marketing Department
Marketing Center
Tel. (81) 3 5739 6331 Fax. (81) 3 5739 6960

KOREA:
KOBE WELDING OF KOREA CO., LTD.
Tel. (82) 55 292 6886 Fax. (82) 55 292 7786

KOBELCO WELDING MARKETING OF KOREA CO., LTD.
Tel. (82) 51 329 8950 to 8952 Fax. (82) 51 329 8949

CHINA:
KOBE WELDING OF SHANGHAI CO., LTD.
Tel. (86) 21 6191 7850 Fax. (86) 21 6191 7851

KOBE WELDING OF TANGSHAN CO., LTD.
Tel. (86) 315 385 2806 Fax. (86) 315 385 2829

KOBE WELDING OF QINGDAO CO., LTD.
Tel. (86) 532 8098 5005 Fax. (86) 532 8098 5008

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KOBELCO WELDING ASIA PACIFIC PTE. LTD.
Tel. (65) 6268 2711 Fax. (65) 6264 1751

THAILAND:
THAI-KOBE WELDING CO., LTD.
Tel. (66) 2 636 8650 to 8652 Fax. (66) 2 636 8653

KOBE MIG WIRE (THAILAND) CO., LTD.
Tel. (66) 2 324 0588 to 0591 Fax. (66) 2 324 0797

VIETNAM:
REP. OFFICE of THAI-KOBE WELDING in DONG NAI
Tel. (84) 61 395 5218

MALAYSIA:
KOBE WELDING (MALAYSIA) SDN. BHD.
Tel. (60) 4 3905792 Fax. (60) 4 3905827

INDONESIA:
P.T. INTAN PERTIWI INDUSTRI
(Technically Collaborated Company)
Tel. (62) 21 639 2608 Fax. (62) 21 649 6081

INDIA:
KOBELCO WELDING INDIA PVT. LTD.
Tel. (91) 124 4010063 Fax. (91) 124 4010068

EUROPE

NETHERLANDS:
KOBELCO WELDING OF EUROPE B.V.
Tel. (31) 45 547 1111 Fax. (31) 45 547 1100

SWEDEN:
KOBELCO WELDING OF EUROPE AB
Tel. (46) 31 767 55 91

AMERICA

USA:
KOBELCO WELDING OF AMERICA INC.
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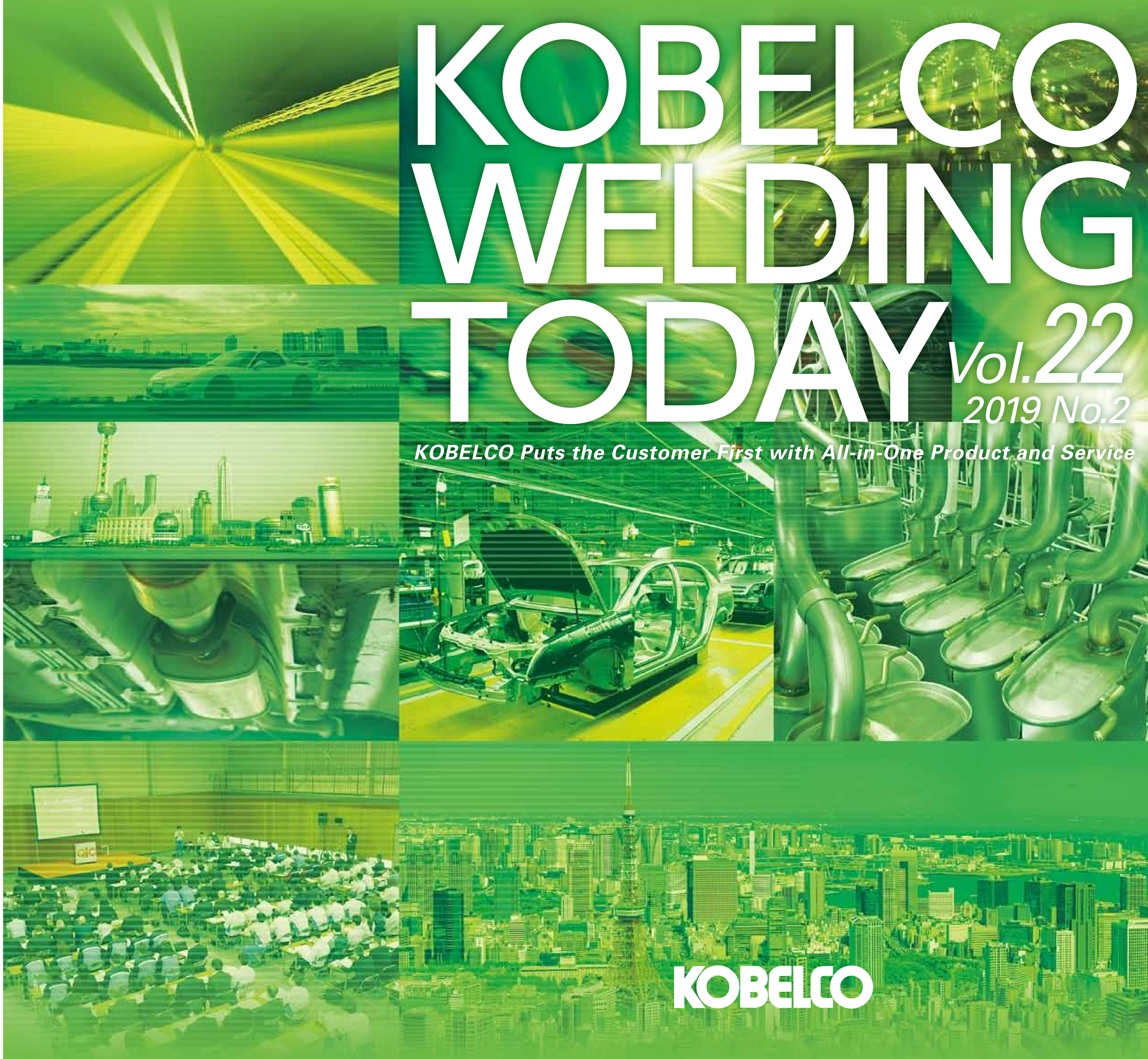
KOBELCO Puts the Customer First with All-in-One Product and Service



KOBELCO

PREMIARC™ MX-A430M
PREMIARC™ MX-T430Nb
Ferritic stainless steel welding consumables for automotive exhaust systems

Ferritic stainless steels have been widely applied in automotive exhaust systems due to their superior corrosion and heat resistance properties and cost performance. For welding in this field, KOBE STEEL's line-up includes solid wires and metal cored wires (MCW) for gas metal arc welding. This article will introduce two MCWs: [P]MX-A430M (1.2 mmφ), which was developed and first marketed in 1989, and the newly-developed [P]MX-T430Nb (1.0 mmφ).

The welding of automobile exhaust system components is complicated because they combine thin pipes and press molding parts. Additionally, in recent years the auto industry has been requiring improved fuel efficiency via weight reduction. Hence, the base metals utilized for these components comprise steel sheets less than or equal to 1.0 mm in thickness.

Although [P]MX-A430M has a proven track record due to its excellent usability, applying it to thin sheets is impractical as it is difficult to produce in diameters smaller than 1.2 mm. For this reason, the smaller diameter [P]MX-T430Nb was developed as it satisfies market demand while maintaining the superb usability of [P]MX-A430M. The chemical compositions of both [P]MX-A430M and [P]MX-T430Nb are shown in Table 1.

Table 1: Chemical composition of deposited metals

(Shielding gas: Ar-20%CO_2)

	C	Si	P	S	Cr	Nb	Ti	Al	N
[P]MX-A430M	0.03	0.41	0.01	0.01	17.3	0.7	0.13	0.10	0.03
[P]MX-T430Nb	0.02	0.39	0.02	0.01	17.7	0.6	0.16	0.11	0.03

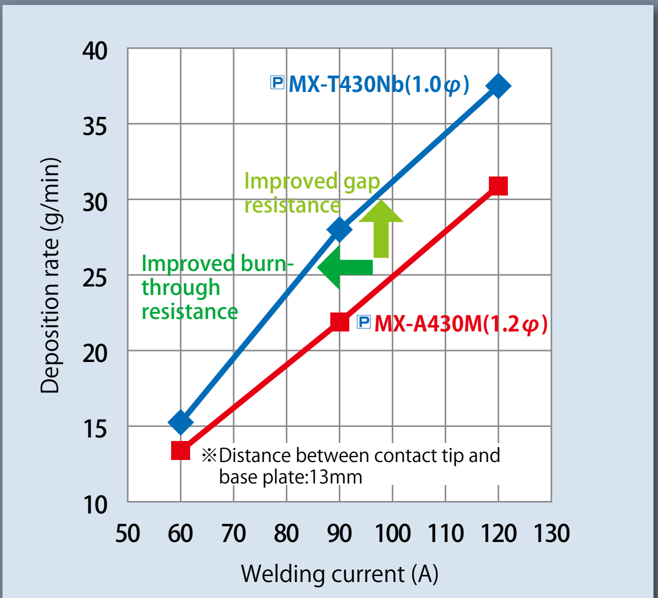


Figure 1: Relationship between welding current and deposition rate

Both 18Cr-Nb-type MCWs improve crack and corrosion resistance by utilizing trace elements to refine the microstructure of weld metals.

Furthermore, [P]MX-T430Nb (1.0 mmφ) has wire strength equivalent to or more than that of [P]MX-A430M (1.2 mm φ). This allows wire to be fed through a complex path during welding or improves wire feeding in a complicated robotic welding operation.

Figure 1 displays the relationship between welding current and deposition rate of both MCWs. It can be seen that [P]MX-T430Nb obtains a higher deposition rate than [P]MX-A430M under the same welding current. It shows that the welding current required to get the same amount of deposited metal is lower for [P]MX-T430Nb than for [P]MX-A430M. Because of this, [P]MX-T430Nb will prevent burn-through more easily. Furthermore, because [P]MX-T430Nb provides more deposited metal under the same welding current, the welding beads will be thicker and wider and be able to fill fluctuated gaps more easily, depending on the assembling accuracy of base metals.

The weldability of [P]MX-T430Nb was evaluated on sheets simulating a muffler part with gaps, and the welding conditions and result are shown in Figures 2 and 3, respectively.

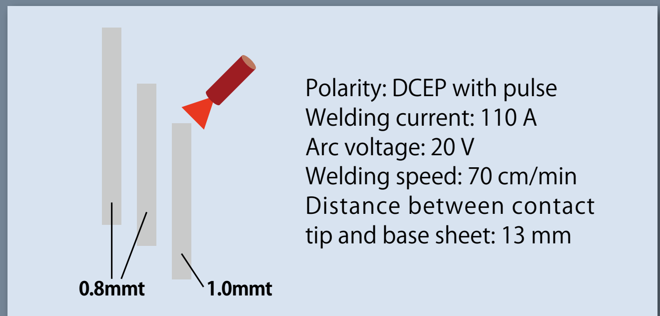


Figure 2: Welding condition

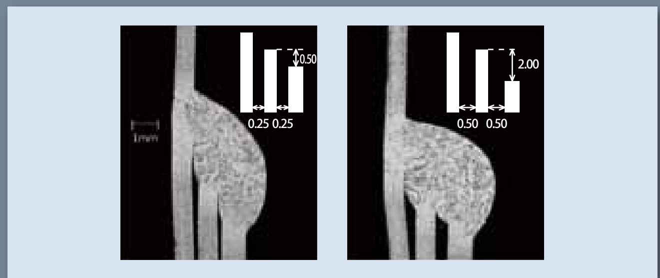


Figure 3: Examples of gap resistance evaluation with [P]MX-T430Nb

As shown in Figure 3, burn-through was not observed under different gaps (0.25 mm and 0.50 mm), and an excellent cross-linking characteristic was confirmed. It is concluded, therefore, that [P]MX-T430Nb obtains wide gap tolerance even in actual operation.

Quality management is in progress in the Welding Business as well as KOBE STEEL

In September 2016, following the big re-organization of the Welding Business, the Quality Management Department (QMD), an independent group within the Welding Business and the first such department in all of KOBE STEEL, was established in order to firmly assure quality as well as compliance for the group. Since then, we, in the QMD, have been acting to realize the Welding Business' vision: "to aim to be the most reliable welding solutions company in the world," with quality as a pillar of the company management. Let me discuss our approach to quality management in the Welding Business group.

As for the KOBE STEEL's misconduct related to quality that became public in October 2017, we feel deeply sorry for the trouble and anxiety it has caused. In the Welding Business, right after the incident we performed a voluntary inspection of quality, with a tentative investigation by the Certification Authority and a quality audit by KOBE STEEL headquarters, in which no inappropriate activity was observed. Therefore, we are certain that the products manufactured by the Welding Business group have no issues related to quality at all.

In the whole KOBE STEEL group, measures have been taken to prevent a recurrence of the problems and ensure the supply of "reliable quality." In concrete terms, the measures fall into three categories: (1) Governance, (2) Management and (3) Process.

(1) Governance: Across the whole KOBE STEEL group, the quality governance system has been under reconstruction. In detail, the Next 100 Project and the new Quality Charter as a guideline for quality were established to recover our group's reliability. In the Welding Business group, we have set up an independent quality assurance (QA) function in each production base by reviewing the QA system.

(2) Management: Across the whole KOBE STEEL group, a thorough quality management project has been carried out. In short, human resources development related to QA and in-house training related to quality were executed. In the Welding Business group, we received a quality audit carried out by KOBE STEEL headquarters in all of the Welding Business group's 17 bases, and nothing inappropriate was observed.

(3) Process: In the whole KOBE STEEL group, strengthening of quality control (QC) processes has been in progress. We have been working to eliminate any chance of inappropriately dealing with test and inspection data. In the Welding Business, automation of test and inspection data input and data transfer is under development. We will eliminate the opportunity of misconduct by excluding one-man operations through double checking of manual tasks.

We will continue working on these tasks in the future as well to provide our customers with products and services that can be accepted with confidence, contributing to our clients and society through quality as a leader of the welding industry and placing quality as a management pillar.

Finally, we thank you very much for your continuous patronage of KOBELCO products as well as service. Go-Anzen-Ni (Be safe)!

Kazuyuki Suenaga
Senior General Manager
Quality Management Department, Welding Business
KOBE STEEL, LTD.

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[F], [T] and [P] in trade designation indicate FAMILIARC™, TRUSTARC™ and PREMIARC™ respectively.

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Solid wires for thin steel sheets: TRUSTARC™ MG-S120T for ultra-high tensile strength and, FAMILIARC™ MG-1T(F) for wire feeding control

1 Preface

As the requirements for improved fuel efficiency and reduced carbon dioxide (CO_2) emissions have increased in the auto industry, one approach for reducing vehicle weight has become increasingly popular. This approach has been to apply steel sheets that are thin but extremely high in strength. Along these lines, welding consumables that obtain high strength are also required to secure the strength of welded joints applied to such high tensile steel plates. For welding of such thin steel plates to be carried out, the welding procedure calls for low heat input as well as suitable consumables because under these conditions, the risk of burn-through increases.

Because thinner steel sheets reduce rigidity and fatigue strength of automotive framework members and pose greater risks in relation to corrosion, a technology that addresses these concerns is necessary for welding automotive suspension components.

In this article, [T] MG-S120T, a solid wire for thin, high tensile strength steel sheets; [F] MG-1T(F), another solid wire designed exclusively for wire feeding control in high speed arc welding of thin steel sheets; and a welding procedure that improves corrosion and fatigue resistance developed by KOBE STEEL will be discussed.

2 [T] MG-S120T: solid wire for thin, high tensile strength steel sheets

[T] MG-S120T is the solid wire developed for 980-1180 MPa class steel sheets that are high in tensile strength and comparatively thin. Whereas the strength of welded joints is required to be as high as or higher than that of the mother plates, insufficient strength occurs when a conventional solid wire for soft steel sheets is utilized for high tensile strength (e.g. 980-1180 MPa class) steel plates. This is demonstrated in Figure 1, which compares the tensile strength of lap-weld joints welded on 980 MPa class steel sheets with thickness of 1.4 mm by a conventional solid wire (JIS Z 3312 YGW16) and [T] MG-S120T.

In present day automobile manufacturing, thin 980 MPa class high tensile strength steel sheets are applied only in vehicle body or seat frames but not chassis parts. Thin sheets are not appropriate for parts, such as the chassis, that support a vehicle's weight, and thus require not only static strength but also high fatigue strength and rigidity. High tensile steel sheets can be problematic for body frames as well. Although resistance spot welding tends to be adopted, there is a decrease in cross tensile strength (CTS), specified in the JIS Z 3137, that correlates with increases of steel plate strength and carbon equivalent.

KOBE STEEL has studied how steel plate's strength, carbon equivalent, welding method and consumables can influence CTS. The results are shown in Figure 2. It was found that decreases in CTS were restrained by applying [T] MG-S120T and arc spot welding.

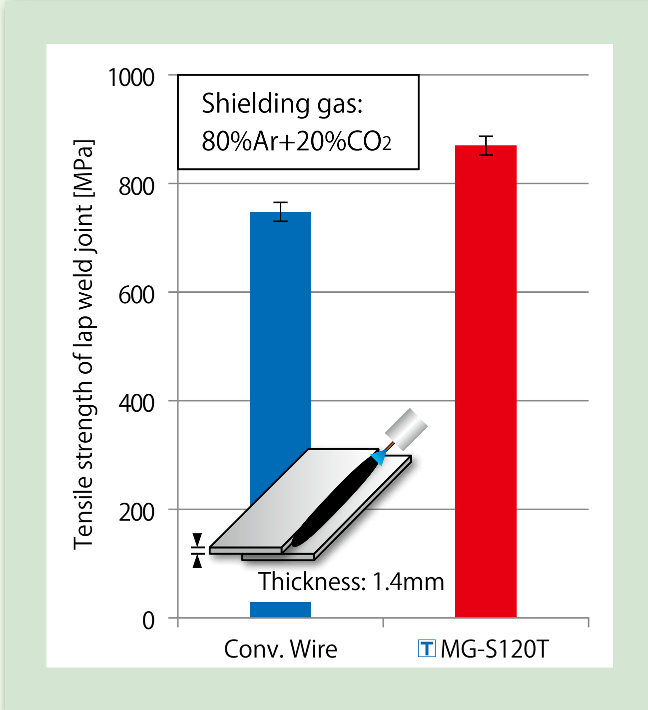

Figure 1: Comparison of tensile strength of lap joints welded with conventional (JIS Z 3312 YGW16) and [T] MG-S120T wires on 980MPa class steel sheets

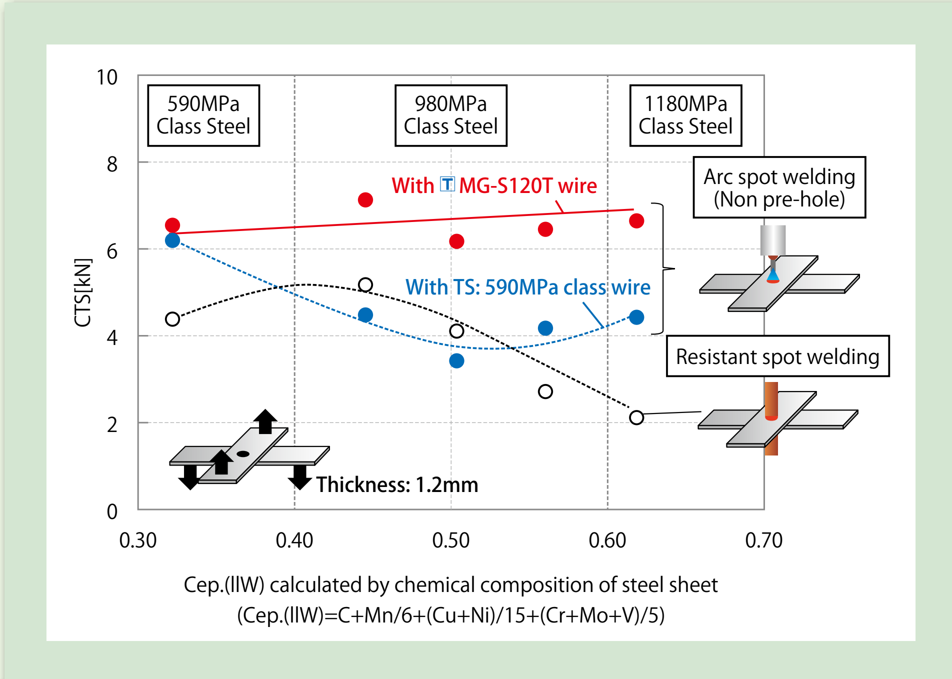

Figure 2: Influence of tensile strength of steel sheet, carbon equivalent, welding method and consumable wire on cross tensile strength

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3 Arc welding via wire feeding control

Wire feeding control has been drawing attention in thin steel sheet welding recently. This is a welding method in which the wire feeding direction is changed alternately forward and backward as shown in Figure 3.

Utilizing both electric and mechanical control, this method allows welding heat input to be reduced in the welding of thin steel sheets, effectively resolving the issue of burn-through as well as reducing spatter. This method even reduces spatter even in the area of globular transfer generated by high welding current, compared with the conventional constant voltage welding method.

On the other hand, because the speed of the alternating forward and backward wire feeding is higher, wear on the contact tips increases drastically as well. Wear at the contact tip will lower the quality due to unstable electric conductivity and an unstable arc.

As a result, welding efficiency is reduced because additional contact tip wear means that tips must be changed frequently in order to maintain stability and quality of welding.

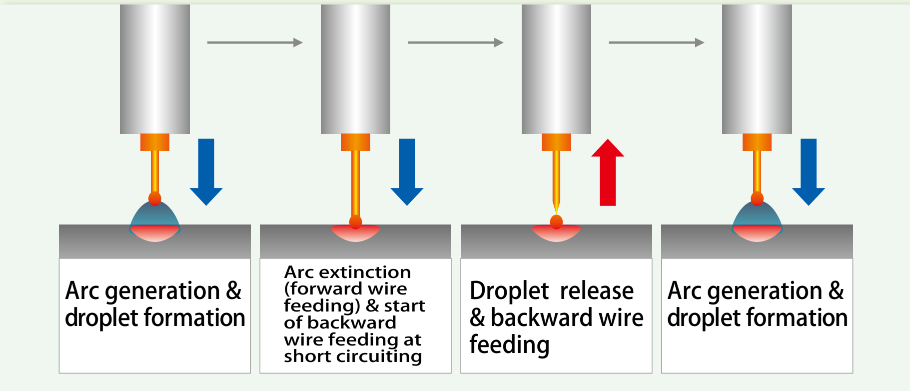

Figure 3: Wire feeding control method

3-1. F MG-1T(F), solid wire for wire feeding control

F MG-1T(F) features a special wire surface treatment that reduces wear of contact tips by decreasing abrasion between the solid wire and the contact tip and maintaining stable electric supply between them.

Figure 4 compares the difference in wear at the contact tips between a conventional solid wire and F MG-1T(F) after one hour of welding by the wire feeding control method.

It can be seen that using F MG-1T(F) wire resulted in about half the amount of wear at the contact tip compared with the conventional wire. In addition to reducing the wear of contact tips, the treatment improves wire feedability and arc stability as well.

The test welding was conducted by using the wire feeding path shown in Figure 5, and the comparison result of time variation in the behavior on the tested welding current, arc voltage and wire feeding resistance between a conventional wire and F MG-1T(F) is shown in Figure 6. It was found that fluctuations in wire feeding resistance were limited.

Table 1 shows an example of F MG-1T(F) with a chemical composition equivalent to JIS Z 3312 YGW12. Mechanical properties were evaluated by weld joints that were made according to JIS requirements, and those of the all-deposit metal are shown in Table 2.

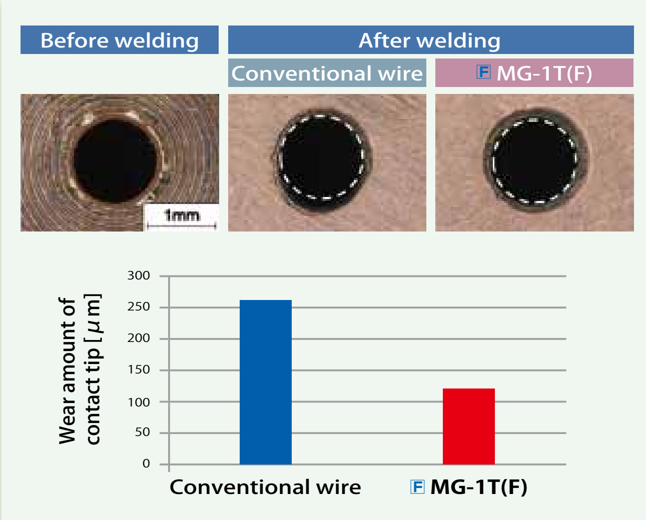

Figure 4: Comparison of wear at the contact tip
※One hour continuous welding at 200A-25V, 100%CO₂ gas

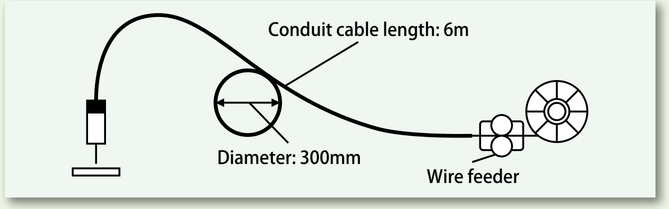

Figure 5: Schematic drawing of wire feeding test

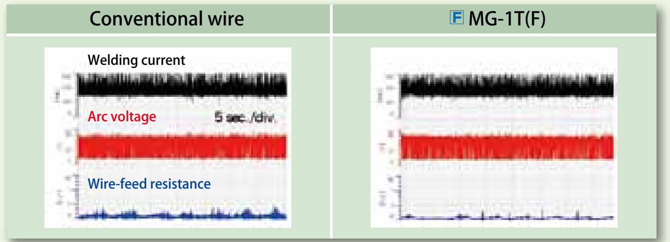

Figure 6: Time variation of welding current, arc voltage and wire feed resistance between a conventional wire and F MG-1T(F)

Table 1: Typical chemical compositions of F MG-1T(F) wire

Wire	C	Si	Mn	P	S	Cu *1
F MG-1T(F)	0.05	0.89	1.40	0.006	0.015	0.24
JIS Z 3312 YGW12	0.02-0.15	0.55-1.00	1.25-2.00	≤0.030	≤0.030	≤0.50

*1: Cu value contains Cu coating

Table 2: Typical mechanical properties of all-deposited metal

Wire	0.2%OS (MPa)	TS (MPa)	El (%)	Absorbed energy at 0°C (J)
F MG-1T(F)	420	530	29	110
JIS Z 3312 YGW12	≥390	490-670	≥18	≥27

4 Properties required for automotive suspension components

As stated above in section 2, among all automotive parts, the suspension components in particular require a high grade of rigidity and fatigue strength. Accordingly, they comprise steel structures where the arc welding process is heavily utilized. Furthermore, high corrosion resistance is required of many of the suspension components as well because they are exposed to more corrosive elements than automotive body frames such as water that splashes during driving or the salt scattered on roads to prevent snow from freezing in cold regions.

However, in arc welding, slag is generated during welding, which causes defects that impede the process of electro-deposition coating after welding. The outer appearance of a suspension component and its weld bead after actual running of a car are shown in Figure 7. Rust is clearly seen near the locations of arc welding where coating defects were generated.

Galvanization is regarded as a satisfactory means of improving the corrosion resistance of steel sheets; however, it is not appropriate for welded parts because welding heat causes the zinc coating to evaporate. Another drawback of galvanized steel sheets is bad weldability in that evaporated zinc gas is likely to remain in the weld metal, leading to the occurrence of porosity defects such as blow holes and/or pits as shown in Figure 8.

Therefore, while arc welding provides many of the properties required for suspension components, improvements in arc welding consumables and welding procedures are needed to avoid the drawbacks mentioned above.

Figure 7: Rust generated on suspension components and weld bead appearance

Figure 8: Porosity defects generated on a weld bead

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4-1. New welding process with excellent corrosion and fatigue resistance

In order to solve the issues discussed above, a new welding process, called the Hi-Ar Process, was developed jointly between KOBE STEEL and Mazda Motor Corp. In this process, the conventional solid wire commonly used as a welding consumable for car production was re-designed to feature little slag generation and superb slag cohesiveness.

Furthermore, the combination of 95%Ar-5%CO_2 shielding gas containing a high Ar ratio with a conventional pulsed power source reduces slag generation while increasing porosity resistance on galvanized steel sheets. Figure 9 compares bead appearance produced by a conventional solid wire (equivalent to JIS Z 3312 YGW12) and the Metal Active Gas (MAG) welding process with 80%Ar-20%CO_2 shielding gas (conventional process) and 95%Ar-5%CO_2 shielding gas (Hi-Ar Process).

In contrast to the conventional process, which produced dotted slag on the bead, the Hi-Ar Process resulted in aggregated slag at the weld-end, a so called crater, which can minimize the places where electro-deposition coating defects can occur.

An evaluation of corrosion resistance after electro-deposition coating was performed in accordance with the combined cyclic corrosion test (CCT), and the results are shown in Figure 10.

Rust is generated at the CCT=10 cycle in the conventional process whereas it is not generated even at CCT=30 cycle in the Hi-Ar Process. Therefore, it is clear that the latter can provide superior corrosion resistance.

Another result of the Hi-Ar Process is that it improves fatigue strength of welded joints. An enlarged cross-sectional macrostructure of a weld toe is shown in Figure 11.

Judging from the flank angle and toe radius of the weld toe configuration, the weld toe obtained by the Hi-Ar Process shows a smooth shape that is unlikely to cause stress concentration in comparison with that by the conventional process.

Figure 12 shows the result of the plane bending fatigue test on fillet welded lap joints of 440MPa class steel plates. The result by the Hi-Ar Process indicates improvement of about 1.5 times in load stress in 1.0 x 10^7 in comparison with the conventional process.

Figure 9: Comparison of bead appearance between 80%Ar-20%CO_2 shielding gas (conventional process) and Hi-Ar Process

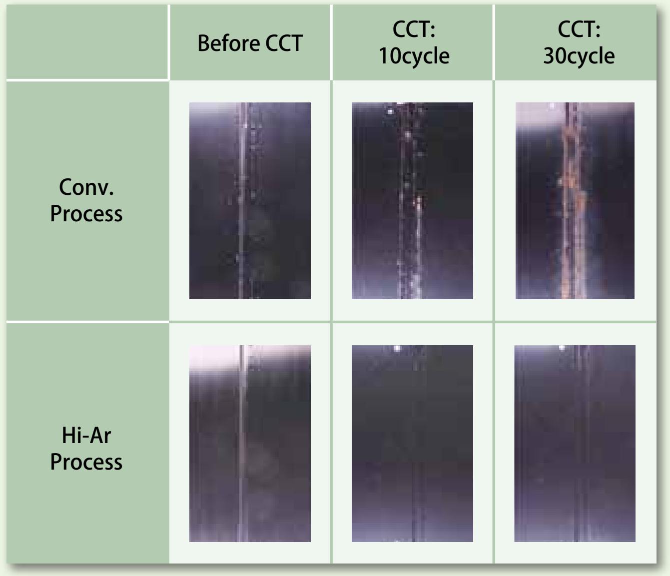
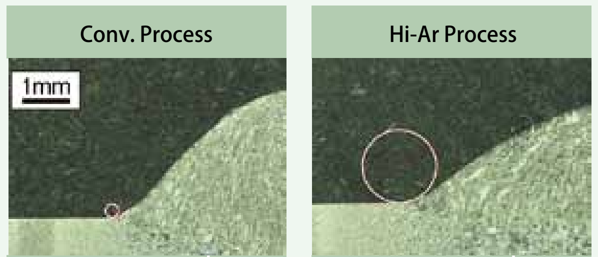


Figure 10: Comparison of corrosion resistance between conventional and Hi-Ar processes



Conv. Process		Hi-Ar Process	
Flank angle [deg]	128	Flank angle [deg]	160
Toe radius [mm]	0.1	Toe radius [mm]	0.7

Figure 11: Comparison of toe shapes

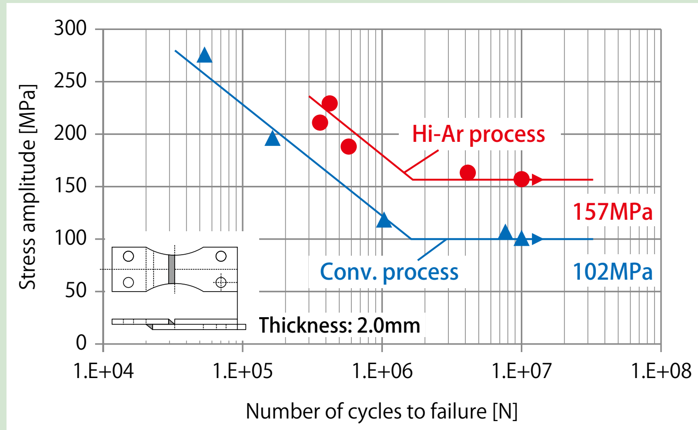


Figure 12: Results of fatigue test ※Stress ratio=0, Frequency=25Hz

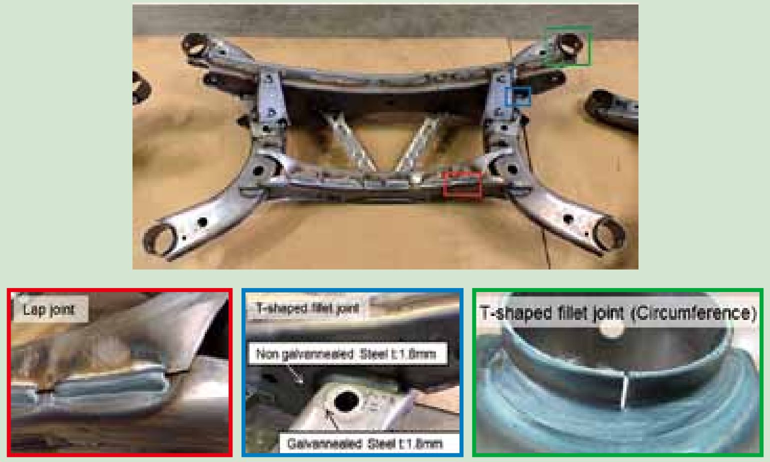


Figure 13: Appearance and welds of suspension cross-members

4-2. Effectiveness of the Hi-Ar Process on actual parts

Actual welding on manufacturing lines can be problematic due to variations in the gaps between steel plates, tack welding accuracy and welding positions, and differs from the evaluations of corrosion and fatigue resistance reported on above. Therefore, an evaluation on actual suspension components for current mass-production vehicles was carried out. The appearance and welds of the suspension cross-members are shown in Figure 13.

In each specimen (a circumferential T-shaped fillet joint, T-shaped fillet joint and fillet welded lap joint), slag is aggregated at a crater, and a smooth bead was obtained. Therefore, the Hi-Ar Process is likely to be effective in welding actual parts and should improve corrosion resistance after electro-deposition coating.

5 Conclusion

The technologies discussed in this article were T MG-S120T, a solid wire for ultra-high tensile strength steel sheets; F MG-1T(F), a solid wire exclusively for welding thin steel sheets and suitable for controlling wire feeding in arc welding; and also the newly-developed Hi-Ar Process, a solution that provides superior corrosion and fatigue resistance.

We expect that the products and the process described above will satisfy the needs of automakers and improve results for the welders who produce automotive parts.

However, as we believe that many issues remain to be resolved, we at KOBE STEEL will continue to develop original technology.

Reported by
Ryota Yamasaki,
Researcher, Technical Center, Welding Business

Chinese Shin-Yo-Kai: KOBE STEEL's welding distribution network in China

Dear KWT readers: Nihao! (Good day!) My name is Hidekazu Suzuki. I was newly appointed to be President of KOBE WELDING OF SHANGHAI CO., LTD. (KWSH) in June, 2019. I'm glad that I have an opportunity to introduce our sales activities in China.

In the Welding Business, three bases have been established in China: KOBE WELDING OF TANGSHAN CO., LTD. (KWT), a solid wire manufacturing company; KOBE WELDING OF QINGDAO CO., LTD. (KWQ), a flux cored wire manufacturing company; and KWSH, which provides Chinese customers with welding solutions in combination with welding consumables that are produced at the above two bases and robotic welding systems and power sources manufactured in Japan.

China is the world's largest market of welding consumables with presumed demand of about three million tons a year. It's a challenging country in which to do business so many types of industries operate here, and an uncountable number of welding consumable manufacturers compete ruthlessly. Making things more difficult are the drastic changes that can suddenly occur in the market. In my case, drastic change happened in the construction machinery industry, which saw a sharp drop in production of as much as 40 % soon after my assumption to the post.

Because the Chinese market is too big for KWSH to cover effectively, marketing activities are performed under a cooperative partnership with our agents. All KWSH employees are working in the Chinese market with the goal of Aiming to be "the most reliable welding solutions company in the world" while providing clients with excellent quality products and service.

Under the supervision of KWSH, an agency system, based on a distribution network, was established in 2013. Then, in June 2015, it changed its name to Chinese "Shin-Yo-Kai" (the name used for all of KOBELCO's welding distribution networks) and has continued in its activities since then. The Chinese Shin-Yo-Kai, which started with 36 agents, now consists of 39 agents. We are very thankful for their work as an extremely important sales network in expanding KOBELCO brand products throughout this large market.

At the beginning of every year, we hold a meeting including a get-together party with all members of the Chinese Shin-Yo-Kai to discuss market trends and sales policies, to introduce core products and to strengthen our unity.

We have also been conducting sales campaigns for core products every year. Following the campaigns, top class agents are rewarded with an educational tour to Japan. The awardees visit KOBE STEEL's plants as well as branch offices for learning and information exchange. In fact, in 2019, the awardees visited Fujisawa Plant to study its core products, stainless flux cored wires, as well as to deepen their understanding of KOBE STEEL.

In the Chinese market, the largest and most intensely competitive in the world, support from local agents is inevitable and essential; therefore, we will proceed with our sales activities by cooperating closely and exchanging information and opinions with all of them.

In the end, I'd like to emphasize that if we wish to build reliable relationships in China, we have to follow the Chinese way, which includes drinking "Baijiu" (white liquor) together, while talking about mutual business and exchanging ways of thinking. Baijiu is popular kind of Chinese vodka with an alcohol percentage of 38 to 50 percents. It is a very aromatic and delicious spirit that goes very well with Chinese cuisine. Let's toast with it together when you visit Shanghai!

Reported by
Hidekazu Suzuki,
President, KWSH

General meeting of Chinese Shin-Yo-Kai and get-together party in January 2019

Reporter, Hidekazu Suzuki, President, KWSH

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The Welding Business holds its 114th QC circle conference

The Welding Business's 114th QC circle conference, one of the group's largest annual events, which brings together representatives from plants around the world, was held at the Ibaraki Plant on the 11-12 April. It was the first time that the conference was held in the Ibaraki Plant's gymnasium due to the large number of participants as shown in the picture below.

As usual, the conference featured presentations on activities conducted over the past year that achieved quality improvement, productivity increase, or cost reduction. It was the largest ever, with reports on 17 cases (8 from Japan and 9 from overseas), and as many as 170 employees took part.

The presentations provided so many satisfying details of how each group achieved their targets and overcame hardships that discussions in the question and answer sessions could not finish within the allotted time. Overseas participants seemed especially keen to absorb as much knowledge as possible in this valuable once-a-year occasion.

As QC circle activities had not been as established abroad as in Japan, their purpose was not well-understood in overseas plants at the beginning. However, through the organization of QC circle conferences as well as periodical exchanges with employees in respective mother plants, overseas plant workers have gradually come to understand and appreciate the meaning and importance of these activities. Nowadays, the level of QC circles overseas is as high as those in domestic plants, and both parties now stimulate each other to do better.

Left : Enjoying a game of bingo at the get-together party in the evening of April 11 Right : Commemoration ceremony

This year's gold prizes were awarded to three domestic plants (Ibaraki, Saijo and Fukuchiyama) and two overseas plants (TKW and KMWT, both in Thailand). Those circles who missed out on the award are certain to burn with competitive energy for next year, while the award winners will be polishing their presentations for the upcoming autumn conference held of the entire KOBE STEEL group. In this way, all of the circles are determined to step forward to the next opportunity.

Aiming to be "the most reliable welding solutions company in the world," we will contribute to our customers' Monodzukuri (production system innovation) through welding and social and environmental development in Japan as well as abroad, while working to enhance Monodzukuri through each employee's passion for quality.

Reported by
Mari Yokoyama,
Global Operations and Marketing Department, Marketing Center, Welding Business

The Welding Business' QC circle conference held at Ibaraki Plant's gymnasium