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Development of Extra-deep Drawing Cold-Rolled Sheet Steels for Integrated Automotive Parts

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Synopsis :

To develop extra-deep drawing (EDDQ) cold-rolled sheet steels for integrated automobile parts, effects of steel chemistry and processing conditions on the mechanical properties of extra-low C steels have been investigated. Strong carbide-forming elements such as Ti and Nb are necessary to stabilize C even in 20 ppm C steels. Ti-bearing steel has superior ductility and drawability to Nb-bearing steel since grain growth at recrystallization is faster in Ti-added steel than in Nb-added steel due to the difference in the precipitate dispersion. A small amount of Nb addition to Ti-stabilized steel is effective in decreasing the planar anisotropy of mechanical properties. High temperature continuous annealing (850-880 °C) and low reduction temper-rolling (about 0.5%) with the use of the Ti and Nb co-addition steels have provided new products with an excellent mechanical property superior to the mechanical property of conventional EDDQ steel. These products have been used for complicated and enlarged automobile parts such as a side outer panel and an oil pan.

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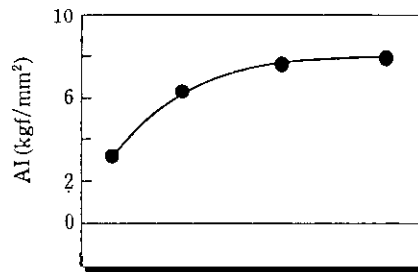


Table 1 Chemical compositions of steels used

Steel*1	C	Ti	Ti*(at.%)	Nb	Nb (at.%)
	(ppm)	(wt.%)	C (at.%)	(wt.%)	C (at.%)
F	32	—	—	—	—
T	24	0.045	3.6	—	—
N	22	—	—	0.065	3.8
PM11	22	0.022	2.4	0.024	—

examined in the three directions; 0°(L), 45°(D) and 90°(T) with respect to the rolling direction. The average

aging property with AI less than 1 kgf/mm² since they contained enough amount of alloying elements to the Q

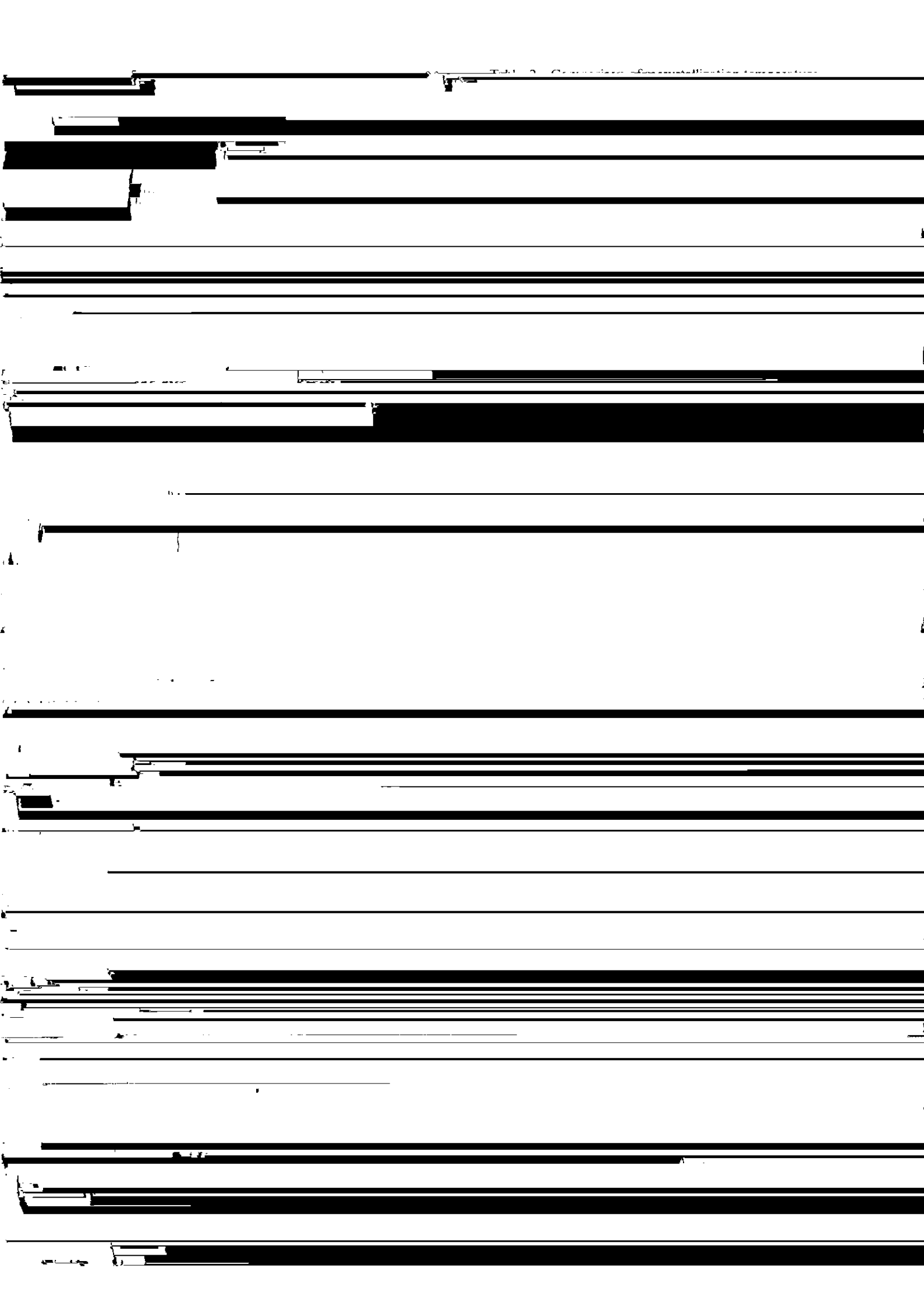
Figure 11 shows the stress-strain curves (0.1% proof stress) of the

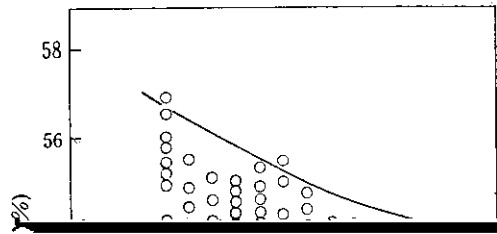
Figure 12 shows the stress-strain curves (0.1% proof stress) of the

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970
980
990
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△ 24 ppmC, Ti*/C=3.6
□ 22 ppm C, Nb/C=3.8

temperature associated with the increase of solute Ti and solute Nb was recognized in other work.⁸⁾ Conse-





○	22 ppmC, 0.025 wt.%Ti, 0.005 wt.%Nb
●	27 ppmC, 0.063 wt.%Ti, 0.003 wt.%Nb



Table 3. Manufacturing conditions and mechanical properties of the epoxy resin system.

Run	Resin	Hardener	Temperature (°C)	Time (min)	Modulus (GPa)	Strength (MPa)	Elongation (%)
1	100	100	100	10	2.5	100	1.5
2	100	100	100	20	2.5	100	1.5
3	100	100	100	30	2.5	100	1.5
4	100	100	100	40	2.5	100	1.5
5	100	100	100	50	2.5	100	1.5
6	100	100	100	60	2.5	100	1.5
7	100	100	100	70	2.5	100	1.5
8	100	100	100	80	2.5	100	1.5
9	100	100	100	90	2.5	100	1.5
10	100	100	100	100	2.5	100	1.5
11	100	100	100	110	2.5	100	1.5
12	100	100	100	120	2.5	100	1.5
13	100	100	100	130	2.5	100	1.5
14	100	100	100	140	2.5	100	1.5
15	100	100	100	150	2.5	100	1.5
16	100	100	100	160	2.5	100	1.5
17	100	100	100	170	2.5	100	1.5
18	100	100	100	180	2.5	100	1.5
19	100	100	100	190	2.5	100	1.5
20	100	100	100	200	2.5	100	1.5
21	100	100	100	210	2.5	100	1.5
22	100	100	100	220	2.5	100	1.5
23	100	100	100	230	2.5	100	1.5
24	100	100	100	240	2.5	100	1.5
25	100	100	100	250	2.5	100	1.5
26	100	100	100	260	2.5	100	1.5
27	100	100	100	270	2.5	100	1.5
28	100	100	100	280	2.5	100	1.5
29	100	100	100	290	2.5	100	1.5
30	100	100	100	300	2.5	100	1.5
31	100	100	100	310	2.5	100	1.5
32	100	100	100	320	2.5	100	1.5
33	100	100	100	330	2.5	100	1.5
34	100	100	100	340	2.5	100	1.5
35	100	100	100	350	2.5	100	1.5
36	100	100	100	360	2.5	100	1.5
37	100	100	100	370	2.5	100	1.5
38	100	100	100	380	2.5	100	1.5
39	100	100	100	390	2.5	100	1.5
40	100	100	100	400	2.5	100	1.5
41	100	100	100	410	2.5	100	1.5
42	100	100	100	420	2.5	100	1.5
43	100	100	100	430	2.5	100	1.5
44	100	100	100	440	2.5	100	1.5
45	100	100	100	450	2.5	100	1.5
46	100	100	100	460	2.5	100	1.5
47	100	100	100	470	2.5	100	1.5
48	100	100	100	480	2.5	100	1.5
49	100	100	100	490	2.5	100	1.5
50	100	100	100	500	2.5	100	1.5