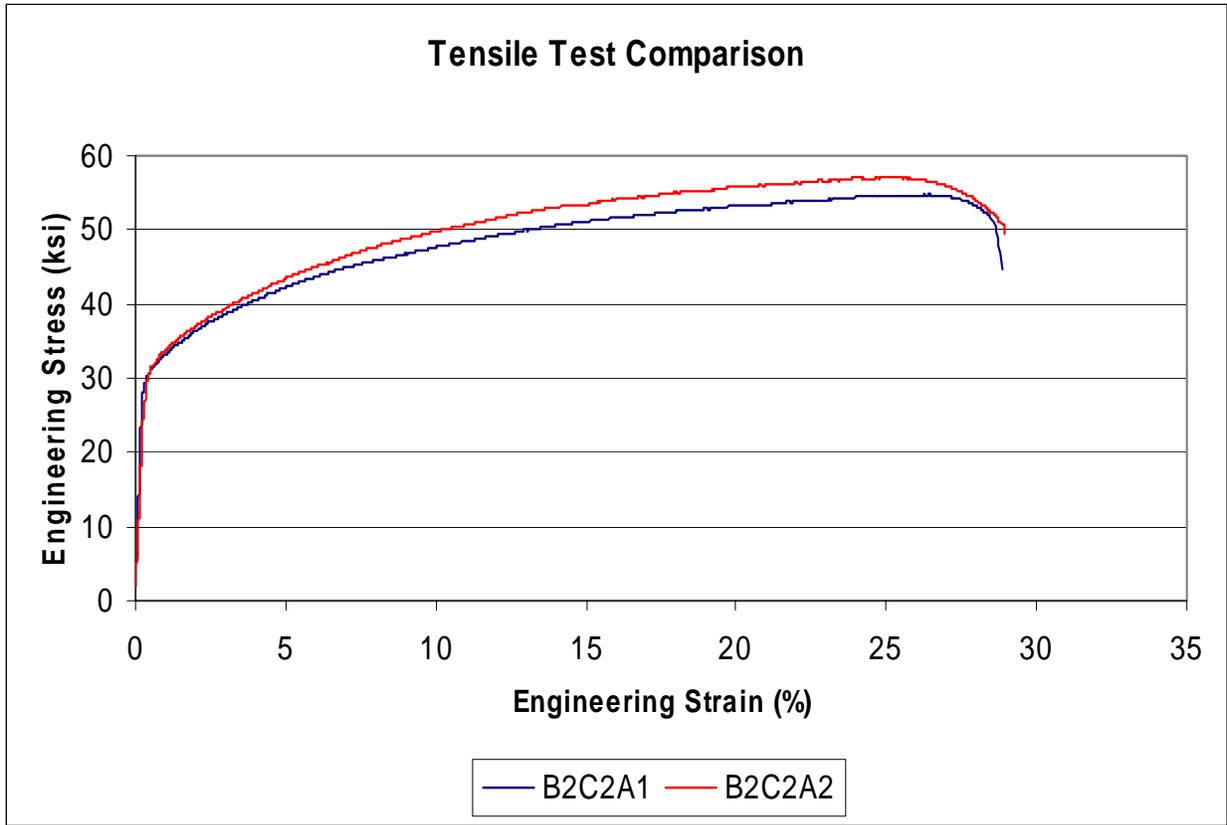


Figure 4.2.7: Microhardness data and low magnification photograph for Sample B2C2B3.

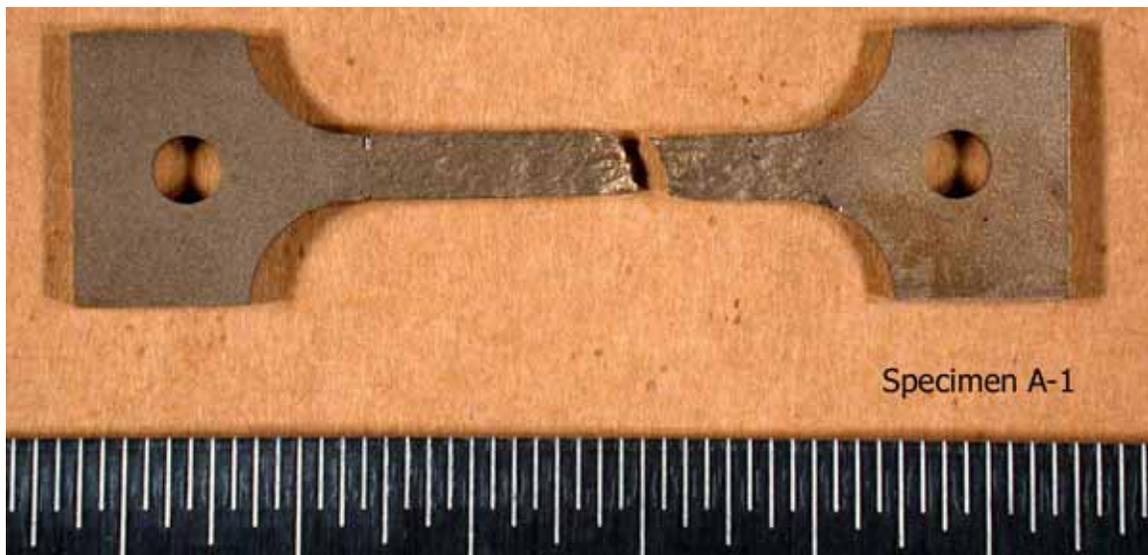


Figure 4.3.1: Tensile specimen design (dummy test specimen shown).



	B2C2A1	B2C2A2
UTS	54,800 psi	57,100 psi
2% Offset YS	30,500 psi	31,300 psi
Elongation	28.7%	28.7%
Reduction in Area	39.3%	34.3%

Figure 4.3.2: Tensile test results for specimen B2C2A1 (near RCS) and specimen B2C2A2 (near low alloy steel).



Specimen B2C2A1 ~1.8X



Specimen B2C2A2 ~1.8X

Figure 4.3.3: Low magnification photographs of tensile specimens after test.



B2C2A1 5X



B2C2A2 5X

Figure 4.3.4: Higher magnification photographs showing fracture location of tensile specimens.

Table 5.1: Sample identification listing for Piece A2A.

Sample ID	Location	Test Plan	Met	SEM
A2A1	A2A section at ~225°	No plan	--	--
A2A2	A2A section at ~170°-190°	Axial cracks at ~180°, see Table 5-2	1	--
A2A3	A2A section at ~135°	No plan	--	--
A2A4	A2A section at ~240°-350°	No plan	--	--
A2A5	A2A section at ~90°	Thin area of clad at 90° (met), see Table 5.3	1	--
A2A6	A2A section at ~350°-70°	Axial crack at 10°; circ. cracks at 20°-45°, see Table 5.4 through Table 5.10	4	4 (2 open cracks, 2 mounts)
A2A7	A2A section, contains exposed clad	Clad cracks; undercut regions, see Tables 5.11 and 5.12	6	4 (2 open cracks, 2 mounts)
A2A8	A2A section, contains cavity nose	No plan	--	--
A2B	Trimmed corner	No plan	--	--

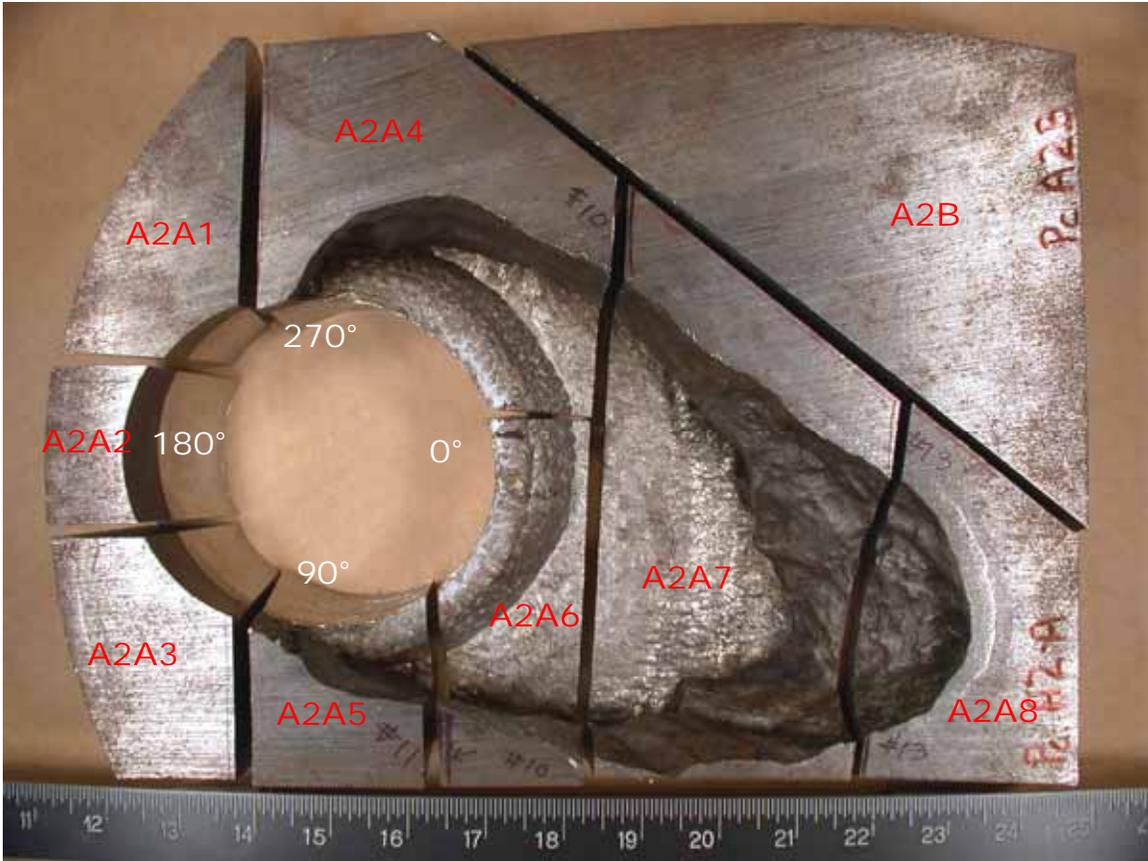


Figure 5.1: Sectioning of Piece A2A (lower portion of cavity) showing new sample identifications.

Table 5.2: Sample identification listing for Piece A2A2.

Piece ID	Location	Test Plan	Met	SEM
A2A2A	Upper portion of nozzle #3 bore	No plan	--	--
A2A2B1	Lower portion of nozzle #3 bore at ~190°	No plan	--	--
A2A2B2	Lower portion of nozzle #3 bore ~180°	No plan	--	--
A2A2B3	Contains axial cracks at ~180° in the J-groove weld.	Met sample through axial cracks	1	--
A2A2B4	Lower portion or nozzle #3 bore at ~170°	No plan	--	--

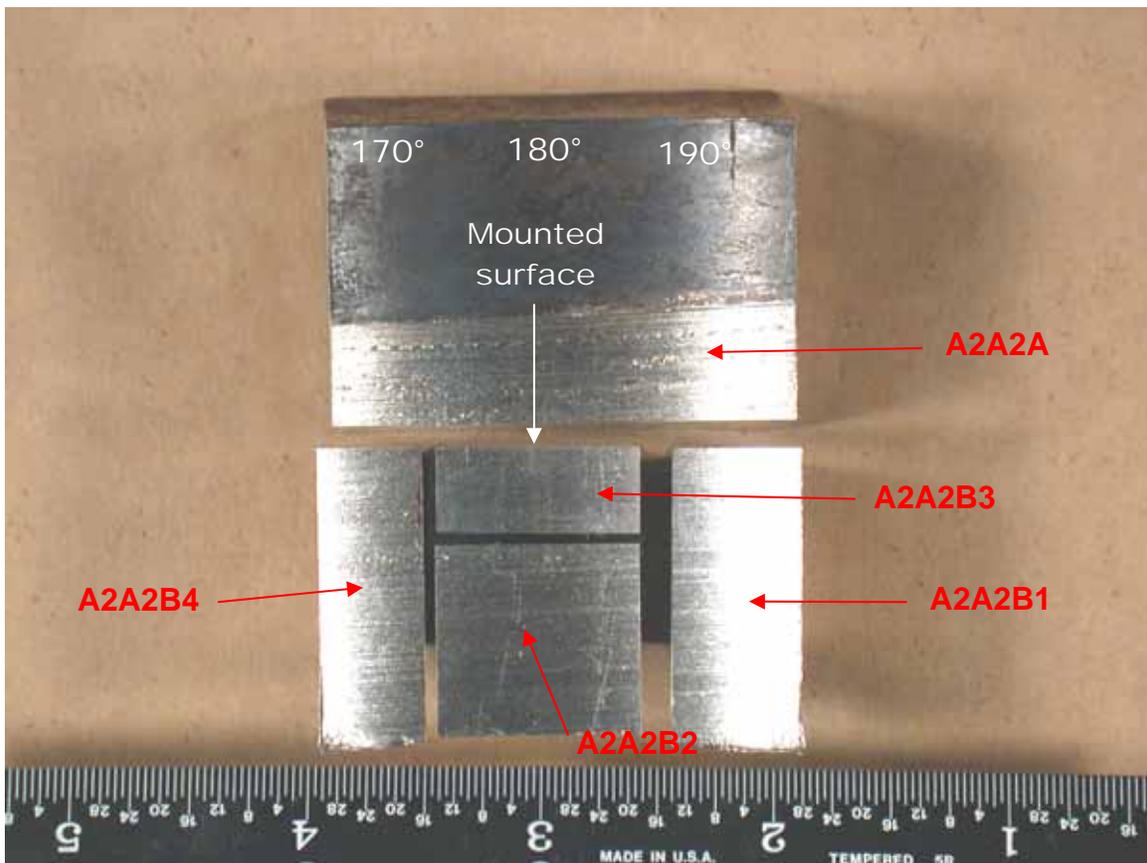


Figure 5.2: Sectioning of Piece A2A2, looking at the ID of the J-groove weld bore.

Table 5.3: Sample identification listing for Piece A2A5.

Piece ID	Location	Test Plan	Met	SEM
A2A5A	RV head near 90°	No plan	--	--
A2A5B	RV head clad near 90°	No plan	--	--
A2A5C	Thin region of clad near 90°	Met sample through thin region	1	--
A2A5D	J-groove weld and clad near 90°	No plan	--	--

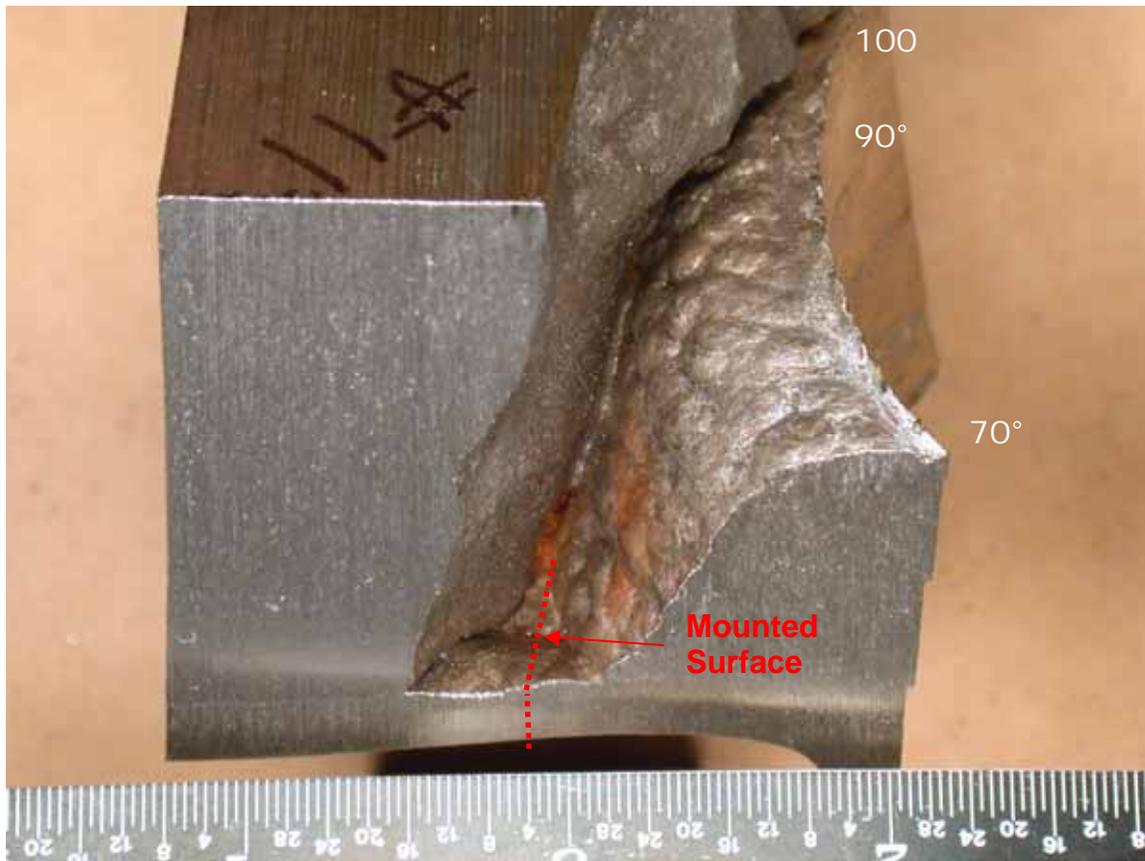


Figure 5.3: Piece A2A5 before sectioning. The mounted surface is indicated.

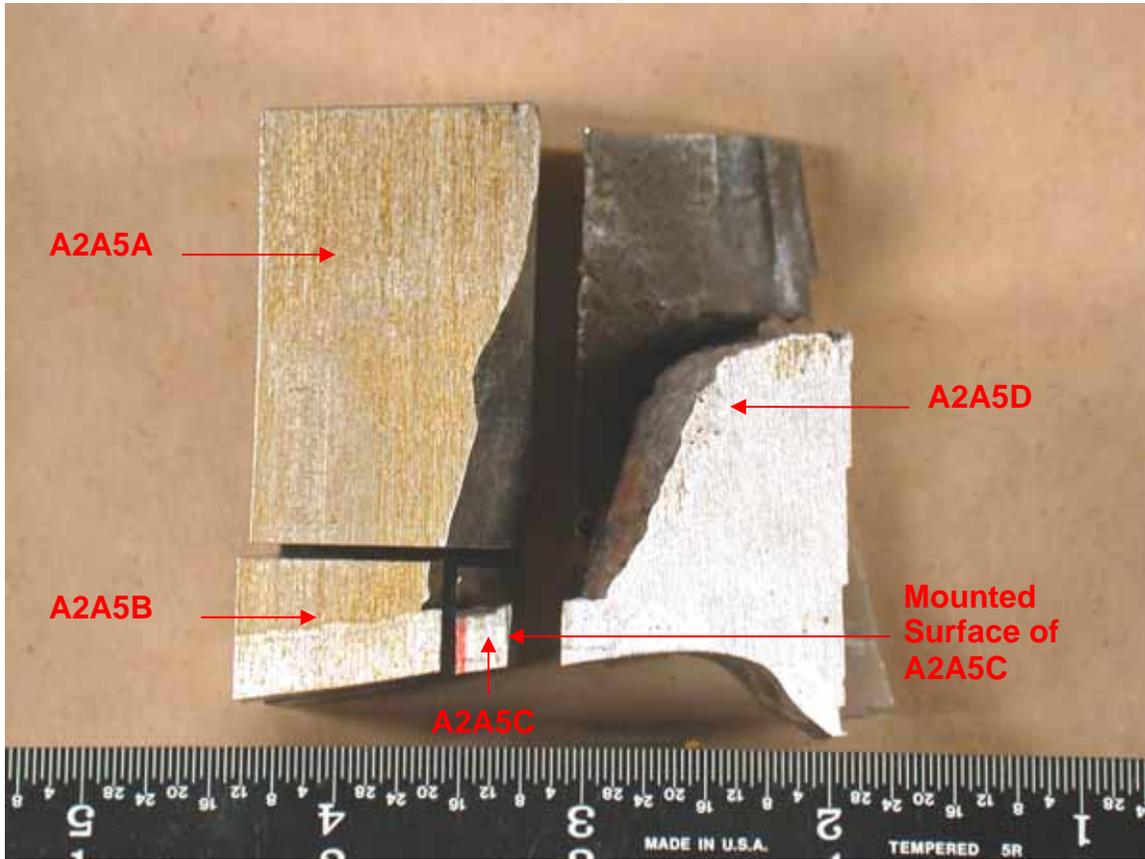


Figure 5.3 (cont.): Piece A2A5 after sectioning, looking down on the front face of previous photo. The mounted surface on sample A2A5C is indicated. This area contained the thinnest measured cladding (0.202”).

Table 5.4: Sample identification listing for Piece A2A6.

Piece ID	Location	Test Plan	Met	SEM
A2A6A1	RV head near 90°	No plan	--	--
A2A6A2 (see below)	Lower portion of J-groove weld and clad from 350°-70°	Contains lower portion of axial crack at ~10° and circ cracks (0°-45°)	3	2
A2A6B (see below)	Upper portion of J-groove weld from 350°-70°	Contains upper portion of axial crack at ~10°	1	2

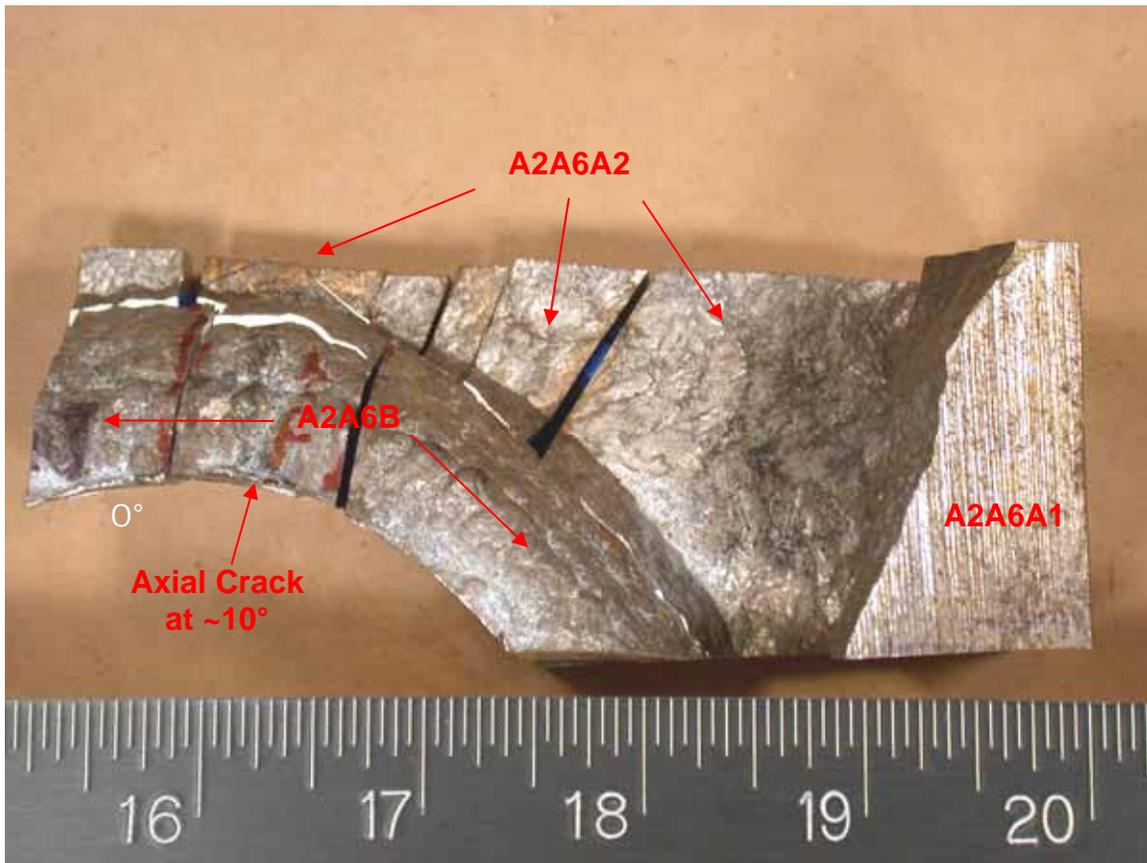


Figure 5.4: Piece A2A6 was first sectioned into Pieces A2A6A and A2A6B. Piece A2A6A was further sectioned into Pieces A2A6A1 and A2A6A2. Both cuts were made on the same plane, parallel to the paper. The first cut line is partially visible; Piece A2A6B is the upper portion of the weld. The second cut line between Pieces A2A6A1 and A2A6A2 is obscured by Piece A2A6A1.

Table 5.5: Sample identification listing for Piece A2A6B.

Piece ID	Location	Test Plan	Met	SEM
A2A6B1	Upper portion of J-groove weld at ~350°	No plan	--	--
A2A6B2	Upper portion of J-groove weld axial crack at ~10°	Lower surface mounted for met/SEM	1	1
A2A6B3	Mid portion of J-groove weld axial crack at ~10°	Open crack SEM sample	--	1
A2A6B4	Upper portion of J-groove weld from 30°-70°	No plan	--	--



Figure 5.5: Piece A2A6B after sectioning. The bottom surface of A2A6B2 was mounted. The axial crack in A2A6B3 was opened up for SEM.

Table 5.6: Sample identification listing for Piece A2A6A2.

Piece ID	Location	Test Plan	Met	SEM
A2A6A2A	Lower portion of J-groove weld and clad at ~70°	No plan	--	--
A2A6A2B	Lower portion of J-groove weld and clad at ~45°	Contains circ crack near 45°	1	--
A2A6A2C	Lower portion of J-groove weld and clad at ~30°	Open circ crack sample for SEM	--	1
A2A6A2D	Lower portion of J-groove weld and clad at ~20°	Contains circ crack near 20°	1	1
A2A6A2E	Lower portion of J-groove weld and clad at ~10°	Contains axial crack and circ cracks at 10°	1	--
A2A6AF	Lower portion of J-groove weld and clad at ~0°	No plan	--	--

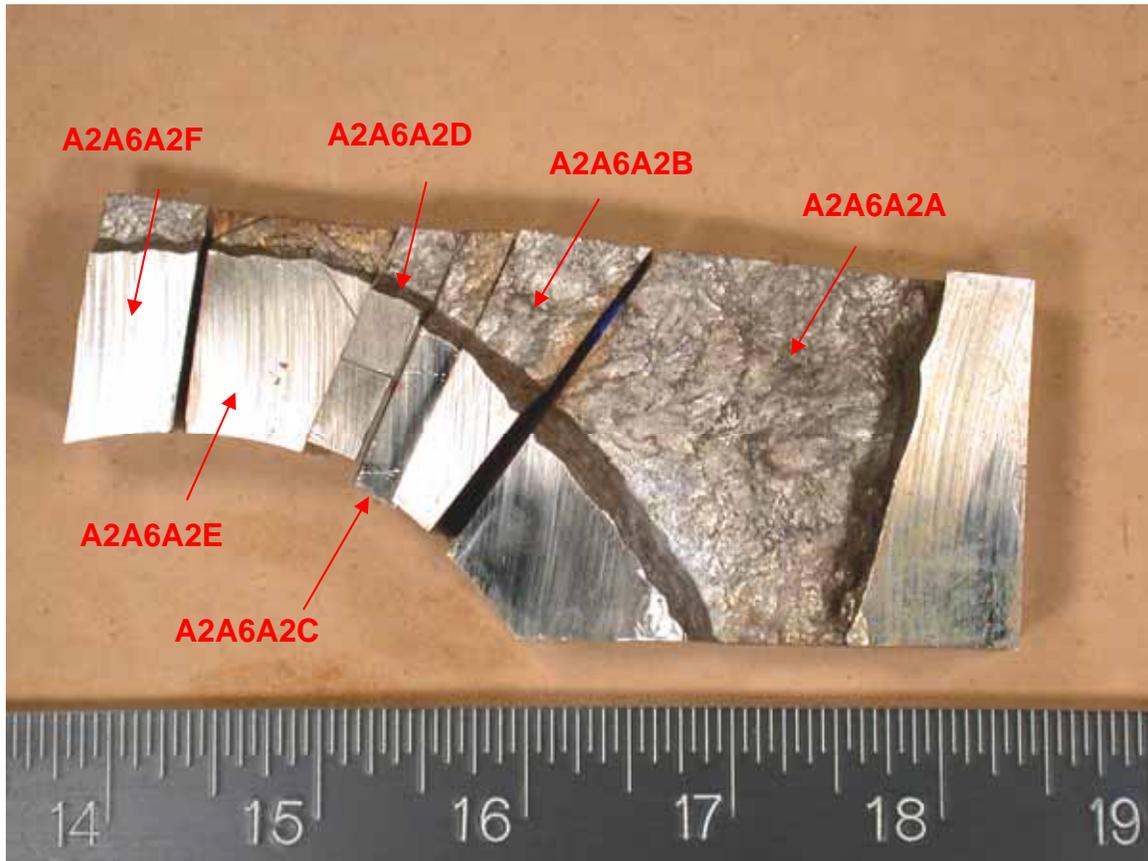


Figure 5.6: Piece A2A6A2 after sectioning. Additional sections were made on A2A6A2B, -C, -D, and -E. Refer to the following four tables and figures.

Table 5.7: Sample identification listing for Piece A2A6A2B.

Piece ID	Location	Test Plan	Met	SEM
A2A6A2B1	Lower portion of J-groove weld at ~45° (includes bore)	No plan	--	--
A2A6A2B2	Lower portion of J-groove weld and clad at ~45°	Contains circ crack near 45°	1	--
A2A6A2B3	Clad at ~45°	No plan	--	--

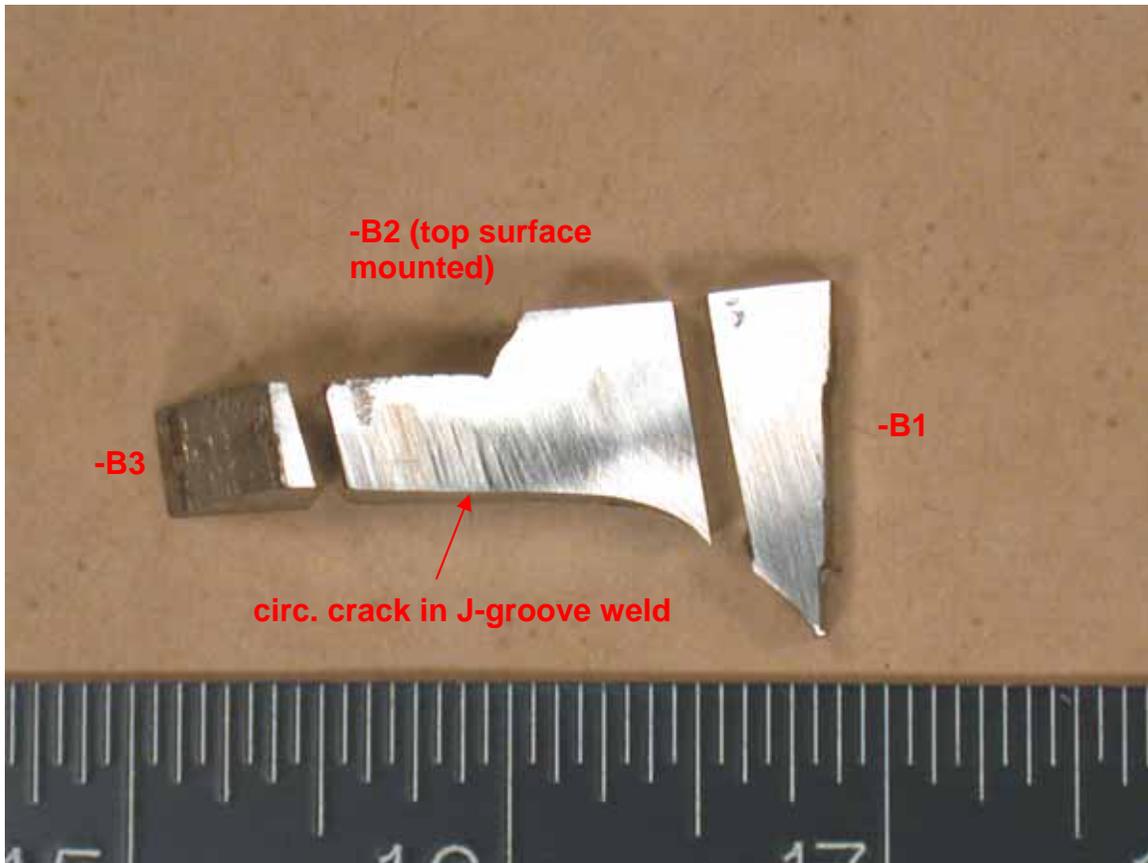


Figure 5.7: Piece A2A6A2B after sectioning (side view of Figure 5.6). The top surface of A2A6A2B2 was mounted.

Table 5.8: Sample identification listing for Piece A2A6A2C.

Piece ID	Location	Test Plan	Met	SEM
A2A6A2C1	Lower portion of J-groove weld and upper surface of clad at ~30° (includes bore)	No plan	--	--
A2A6A2C2	Lower portion of J-groove weld and clad at ~30°	Circ crack near 30° bent open for SEM	--	1
A2A6A2C3	Lower portion of J-groove weld (RCS side)	No plan	--	--

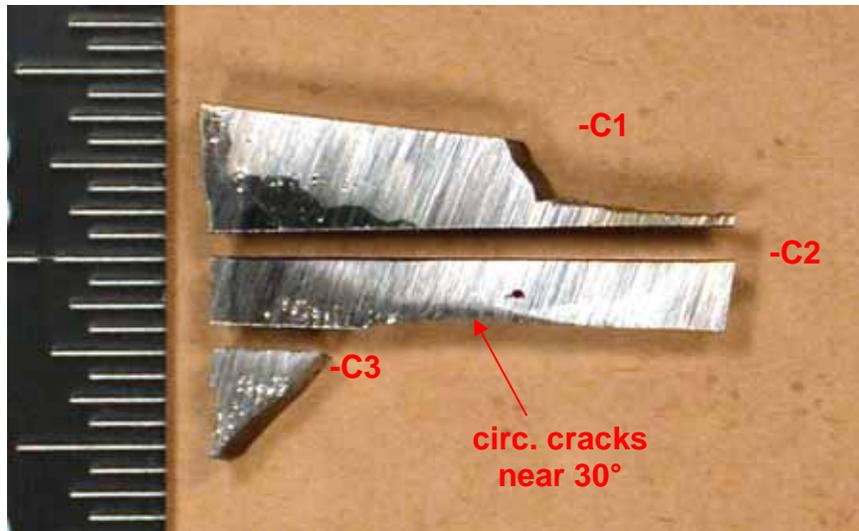


Figure 5.8: Piece A2A6A2C after sectioning (side view of Figure 5.6). The circumferential cracks were bent open for SEM.

Table 5.9: Sample identification listing for Piece A2A6A2D.

Piece ID	Location	Test Plan	Met	SEM
A2A6A2D1	Lower portion of J-groove weld at ~20° (includes bore)	No plan	--	--
A2A6A2D2	Lower portion of J-groove weld and clad at ~20°	Contains circ crack at ~20°	1	1

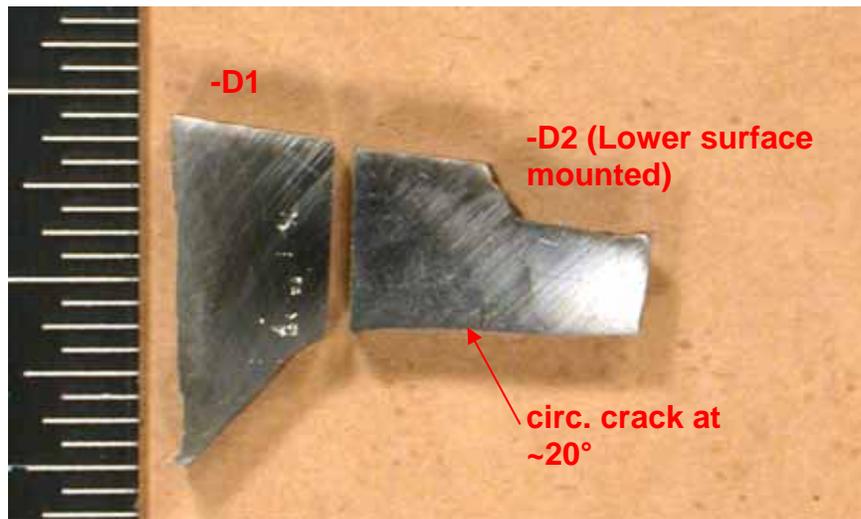


Figure 5.9: Section photo for Piece A2A6A2D (side view of Figure 5.6). The mounted surface of Piece A2A6A2D2 for optical and SEM examination is the lower surface (not visible) in the photo.

Table 5.10: Sample identification listing for Piece A2A6A2E.

Piece ID	Location	Test Plan	Met	SEM
A2A6A2E1	Lower portion of J-groove weld at ~10°	Lower surface mounted for met	1	--
A2A6A2E2	Contains clad at ~20°	No plan	--	--
A2A6A2E3	Contains clad at ~0°	No plan	--	--
A2A6A2E4	Lower portion of J-groove weld (RCS side)	Contains axial and circ cracks at ~10° (PNL Sample)	--	--

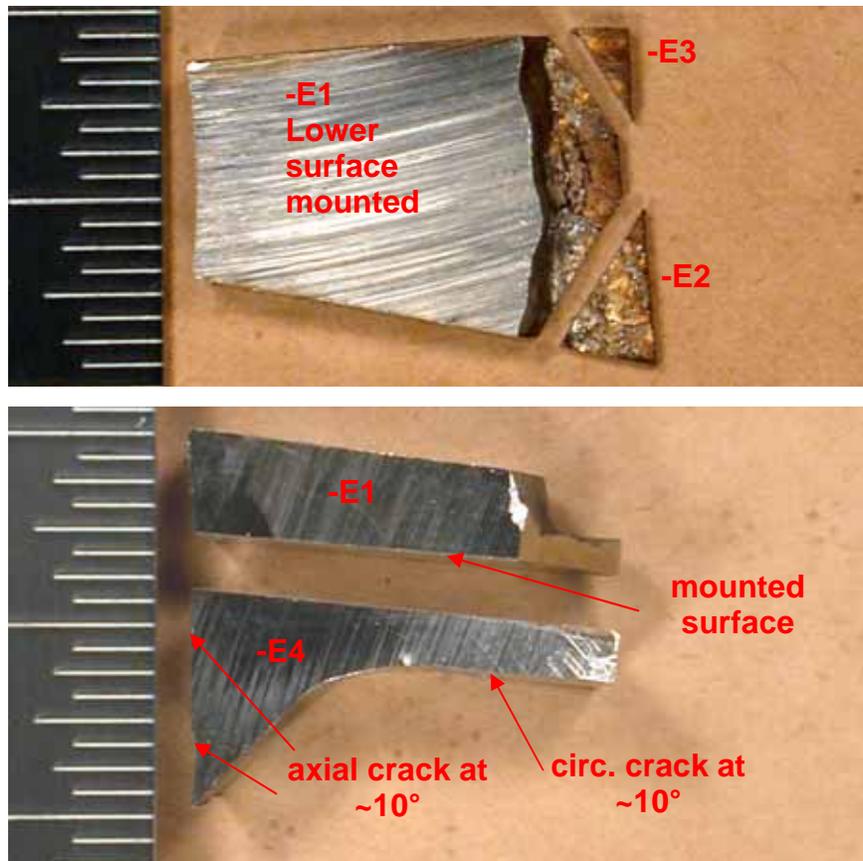


Figure 5.10: Section photo for Piece A2A6A2E (side view of Figure 5.6). The mounted surface of Piece A2A6A2E1 is indicated. Piece A2A6A2E4 is reserved for PNL.

Table 5.11: Sample identification listing for Piece A2A7.

Piece ID	Location	Test Plan	Met	SEM
A2A7A	RV head and clad near 350°	No plan	--	--
A2A7B	RV head and clad near 340°	No plan	--	--
A2A7C	RV head near 345°	No plan	--	--
A2A7D	Undercut region near 345°	Met mount	1	--
A2A7E	RV head and clad near nose	No plan	--	--
A2A7F	Undercut region near nose	Met mount	1	--
A2A7G	RV head near nose	No plan	--	--
A2A7H	Clad prior to nose	No plan	--	--
A2A7I	RV head and clad near 50°	No plan	--	--
A2A7J	RV head and clad near 40°	No plan	--	--
A2A7K	Undercut region near 40°	Met mount	1	--
A2A7L	Center portion of clad cracks	SEM open crack sample	--	1
A2A7M	Adjacent to center cracks	Met mount (center portion)	1	1
A2A7N	Clad cracks toward 270°	Met mount (270°)	1	1
A2A7O	Clad near 0°	No plan	--	--
A2A7P	Center portion of clad cracks	Reserved for PNL	--	--
A2A7Q	Clad near 40°	No plan	--	--
A2A7R	Clad near 40°	No plan	--	--
A2A7S	Clad cracks toward 90°	Met mount	1	1
A2A7T	Clad near 60°	No plan	--	--
A2A7U	Clad near 10°	No plan	--	--



Figure 5.11: Section photo for Piece A2A7. The mounted surfaces for the -D, -F, -K, -M, -N, and -S samples are indicated by the white arrows. Further sectioning of Piece A2A7L is shown in Figure 5.12.

Table 5.12: Sample identification listing for Piece A2A7L.

Piece ID	Location	Test Plan	Met	SEM
A2A7L1A	Center portion of clad cracks	SEM open crack sample	--	1
A2A7L1B	Adjacent to center cracks	No plan	--	--
A2A7L2A	Center portion of clad cracks	SEM open crack sample	--	1
A2A7L2B	Adjacent to center cracks	No plan	--	--

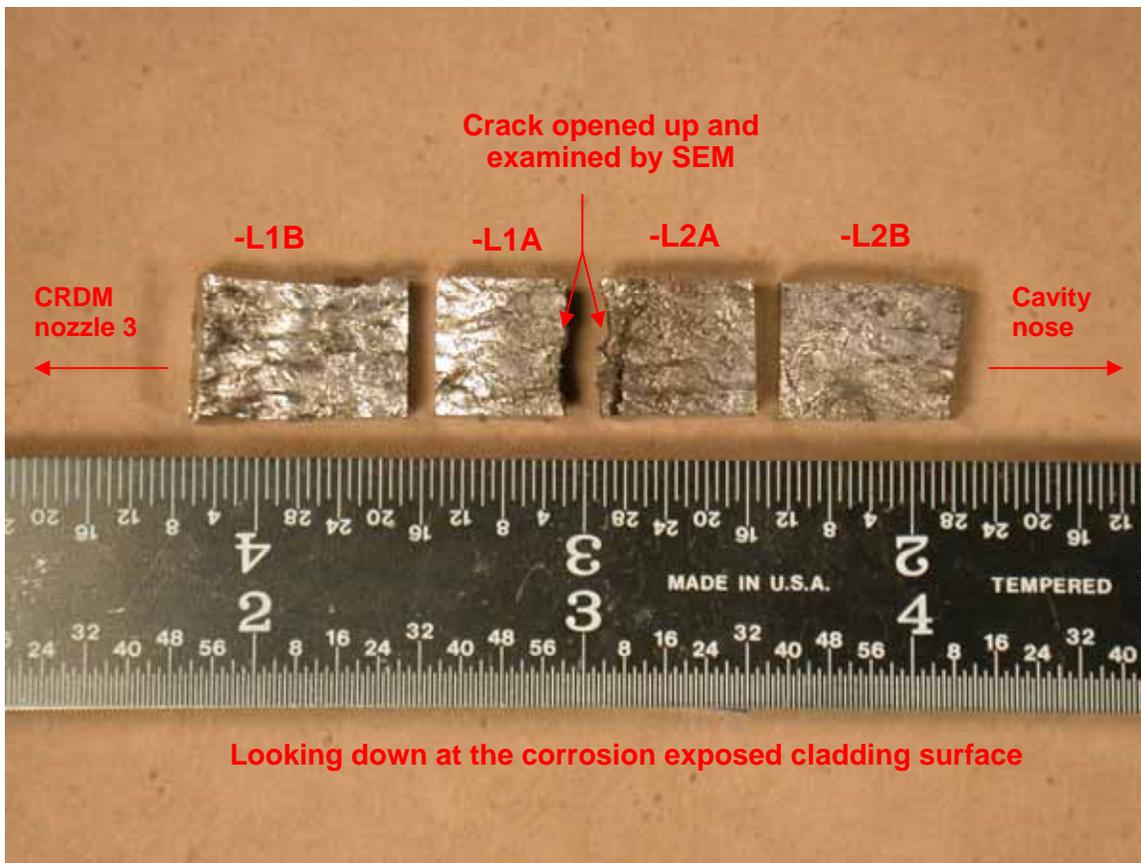


Figure 5.12: Section photo for Piece A2A7L. The main crack located near the center of A2A7L was opened in the laboratory, resulting in Pieces A2A7L1 and A2A7L2. Additional sections, which created the -A and -B pieces, were made to facilitate the SEM examinations. The surfaces examined by SEM are indicated.

Table 5.13: Sample identifications for Piece A1.

Piece ID	Location	Test Plan	Met	SEM
A1A	Contains cavity nose	No plan	--	--
A1B	Contains cavity side wall toward 90°	Met and SEM/EDS samples (see Table 5.14)	2	1
A1C	Contains nozzle #3 bore and small portion of cavity	No plan	--	--
A1D	Contains cavity side wall toward 270°	Met and SEM/EDS samples (see Tables 5.15 and 5.16)	2	1

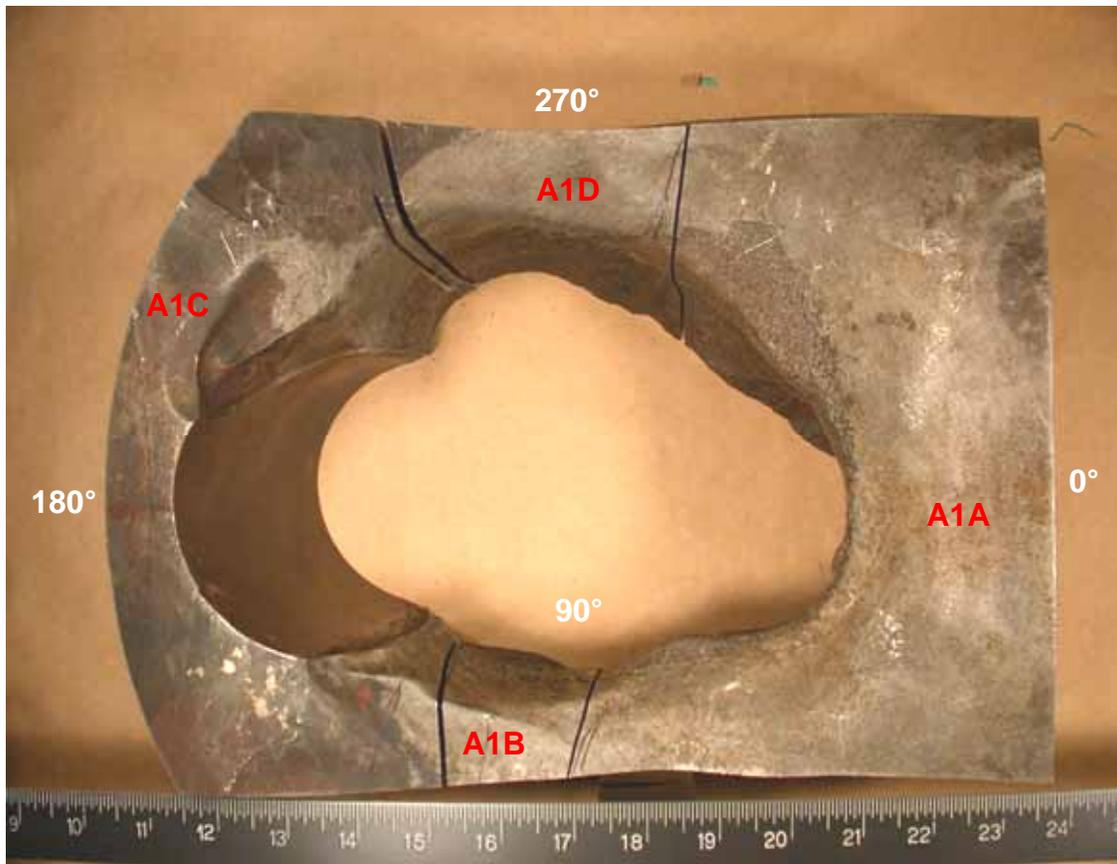


Figure 5.13: Sectioning of Piece A1 into four pieces. Pieces A1B and A1D were further sectioned for metallography and SEM. Refer to Figure 5.14 through Figure 5.16.

Table 5.14: Sample identifications for Piece A1B.

Piece ID	Location	Test Plan	Met	SEM
A1B1	Upper portion of cavity side wall near 90°	No plan	--	--
A1B2	Upper portion of cavity side wall near 90°	Transverse met mount	1	--
A1B3	Middle portion of cavity side wall near 90°	SEM/EDS sample	--	1
A1B4	Lower portion of cavity side wall near 90°	Transverse met mount	1	--
A1B5	RV head behind cavity side wall	No plan	--	--
A1B6	Lower portion of cavity side wall near 90°	No plan	--	--
A1B7	Cavity side wall	No plan	--	--

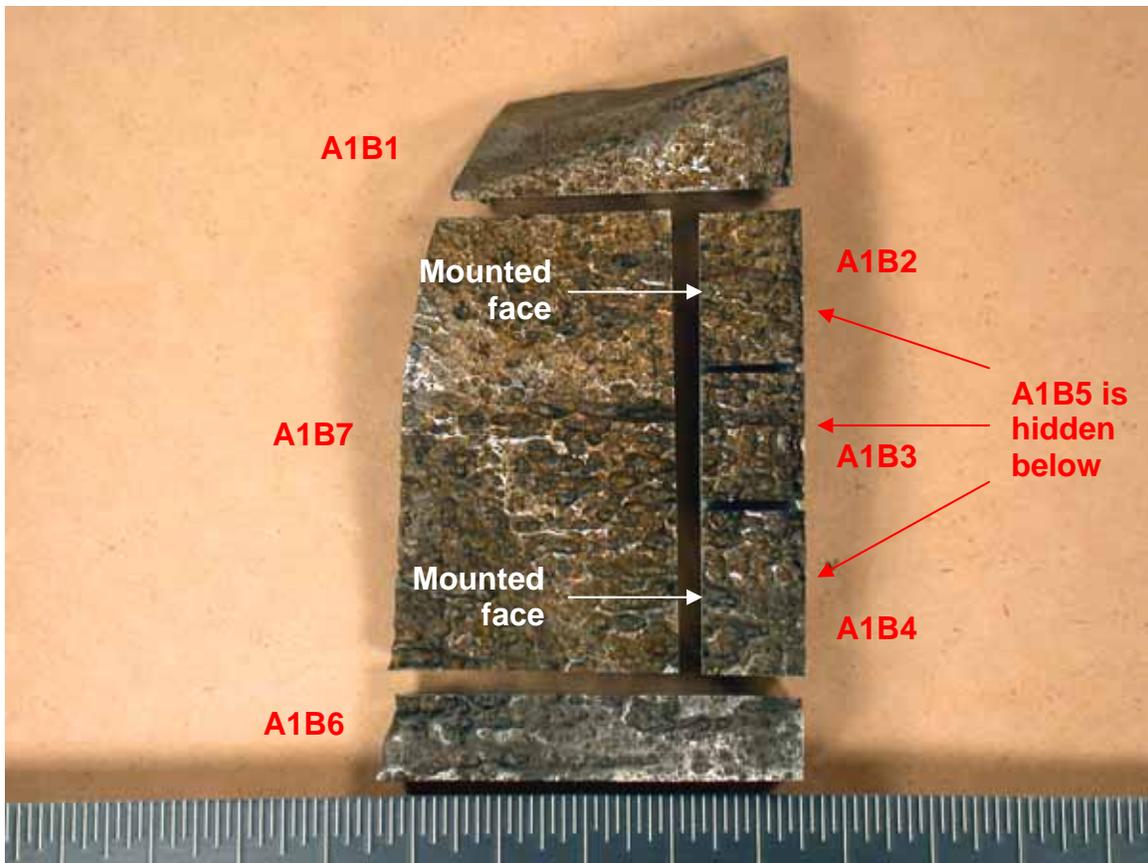


Figure 5.14: Section photo for Piece A1B, looking at the cavity side wall. The mounted surfaces of Piece A1B2 and Piece A1B4 is indicated.

Table 5.15: Sample identifications for Piece A1D.

Piece ID	Location	Test Plan	Met	SEM
A1D1	Cavity side wall near 270°	No plan	--	--
A1D2A	Upper portion of cavity side wall near 270°	No plan	--	--
A1D2B	Upper portion of cavity side wall near 270°	Transverse met mount location	1	--
A1D2C	Middle portion of cavity near 270°	SEM/EDS	--	1
A1D2D	Lower portion of cavity side wall near 270°	Transverse met mount location	1	--
A1D2E	RV head behind cavity side wall	Macroetch sample	--	--
A1D2F	Lower portion of cavity near 270°	No plan	--	--

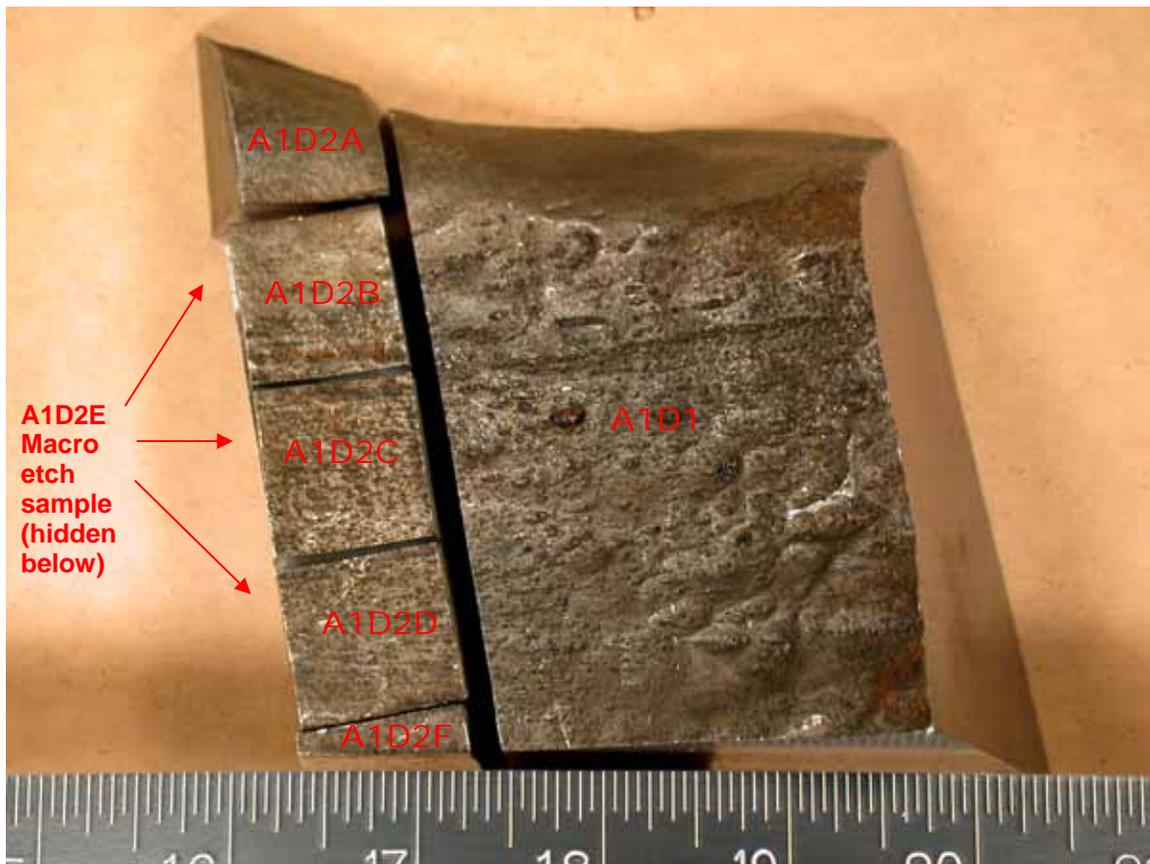


Figure 5.15: Section photo for Piece A1D, looking at the cavity side wall. Refer to Figure 5.16 for the mounted surface locations.

Table 5.16: Sample identifications for Piece A1D2B and Piece A1D2D.

Piece ID	Location	Test Plan	Met	SEM
A1D2B1	Upper portion of cavity side wall near 270°	Transverse met mount location	1	--
A1D2B2	Upper portion of cavity side wall near 270°	No plan	--	--
A1D2D1	Lower portion of cavity side wall near 270°	Transverse met mount location	1	--
A1D2D2	Lower portion of cavity side wall near 270°	No plan	--	--

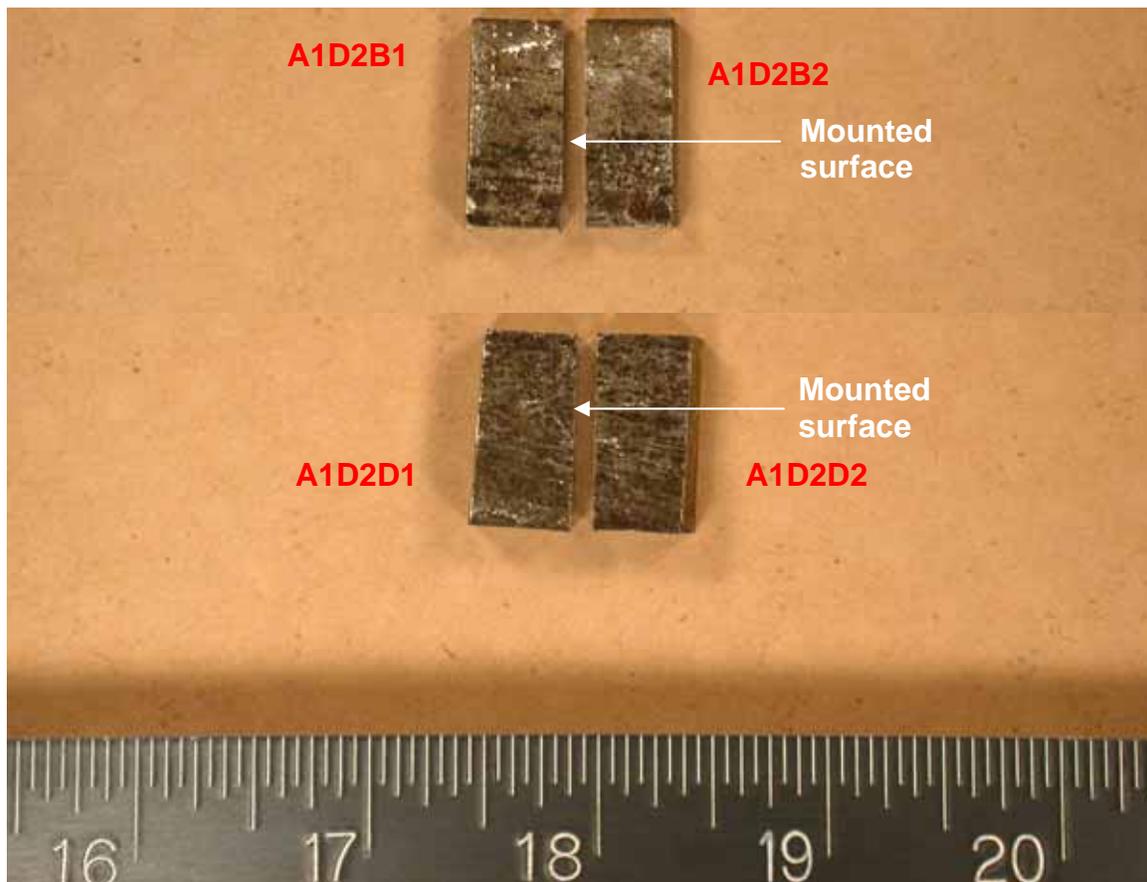


Figure 5.16: Section photo for Pieces A1D2B and A1D2D, looking at the cavity side wall. The mounted faces for Piece A1D2B1 and Piece A1D2D1 are indicated.

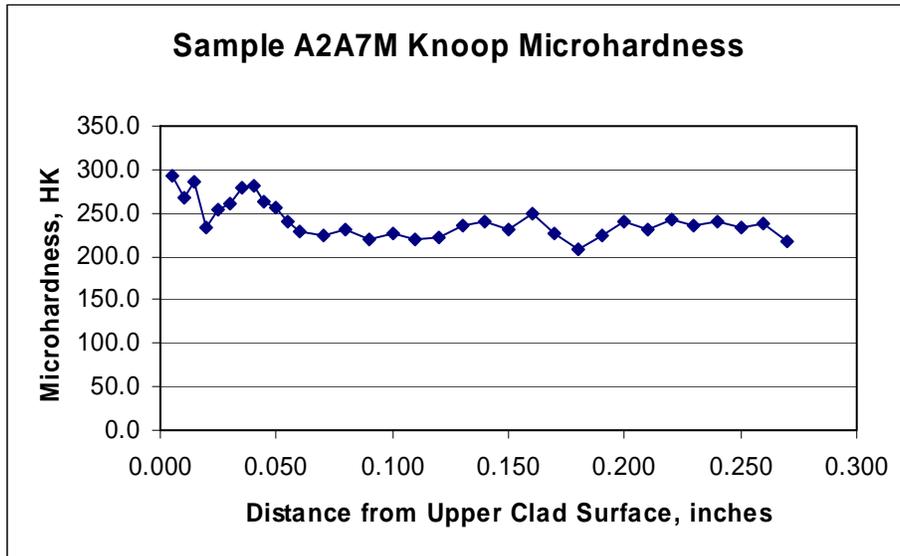
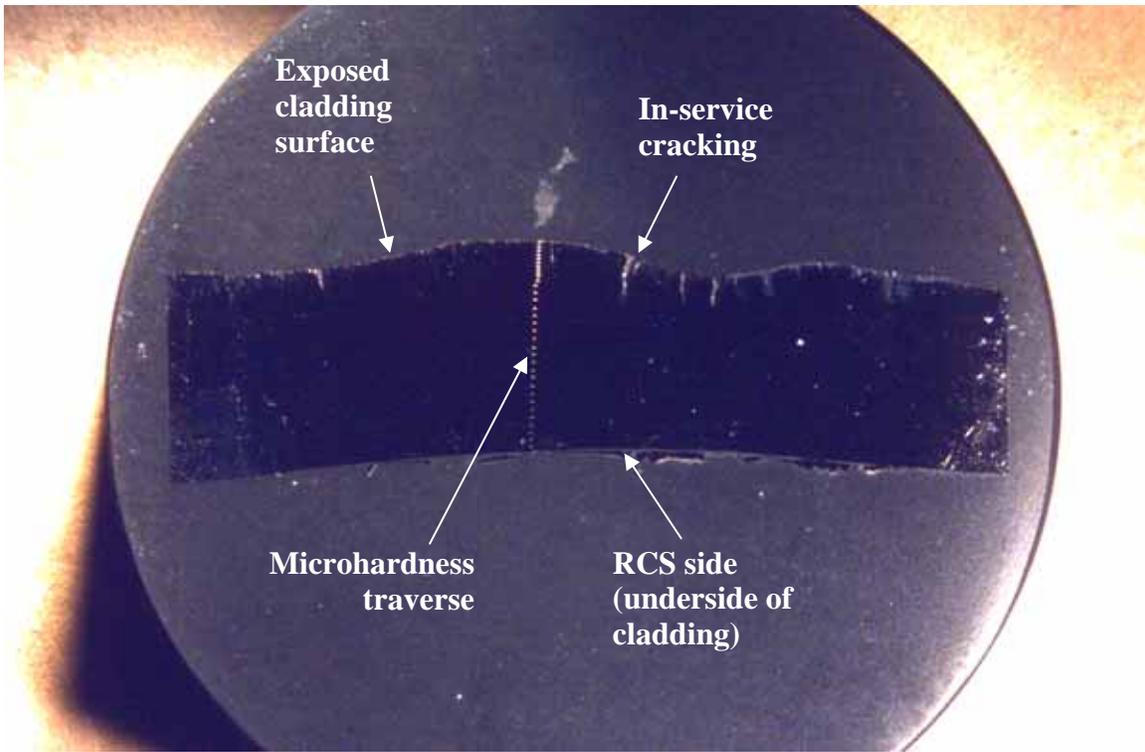
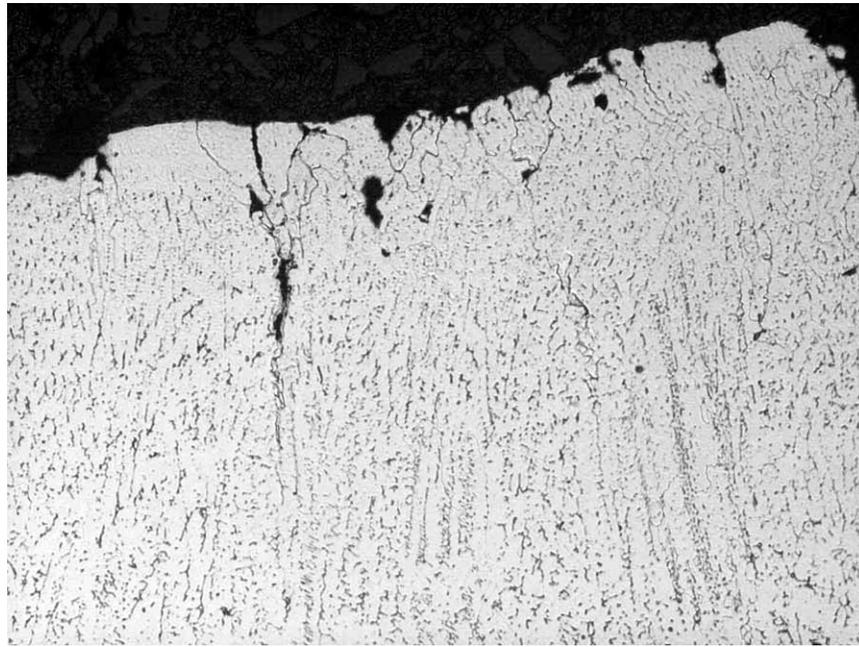
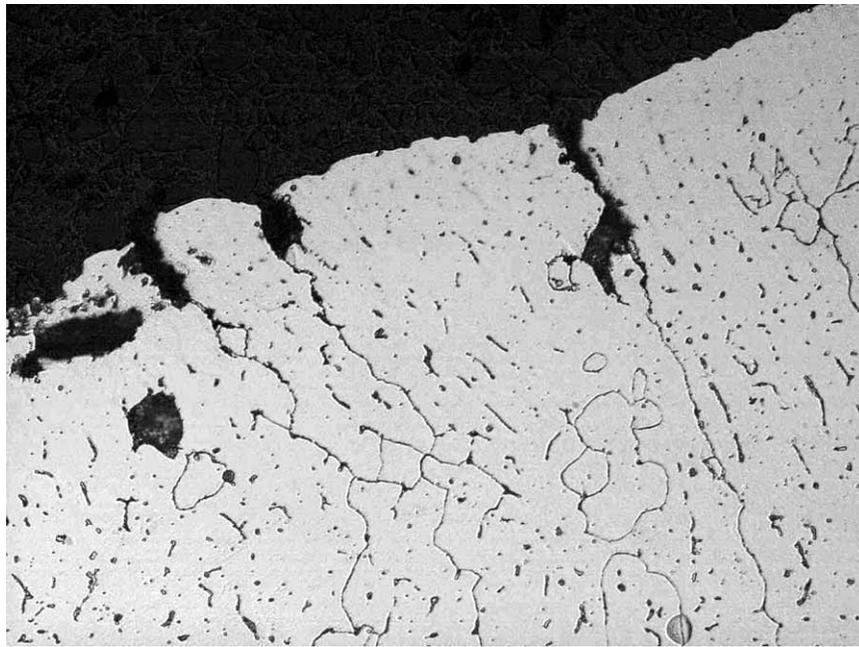


Figure 6.1.1.1: 4X macro photograph of metallurgical mount A2A7M. Refer to Figure 5.11 for the sample orientation. Cladding thickness ranged from 0.227" to 0.277" (5.77 to 7.04 mm). Knoop microhardness values exhibited a hardness elevation near the exposed cladding surface.



Etched

100X



Etched

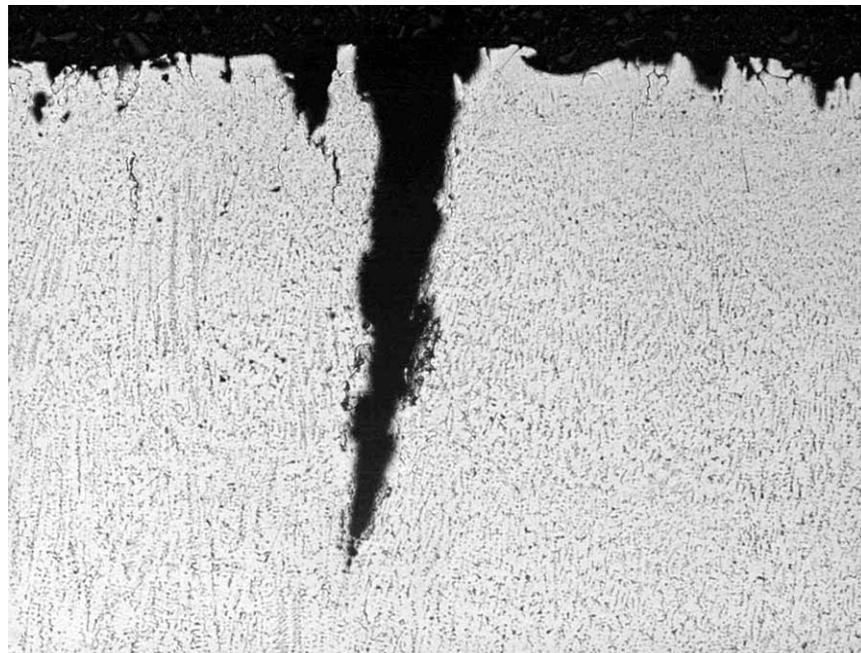
375X

Figure 6.1.1.2: Micrographs showing intergranular attack (IGA) and intergranular or interdendritic cracking on the exposed stainless steel cladding.



As-polished

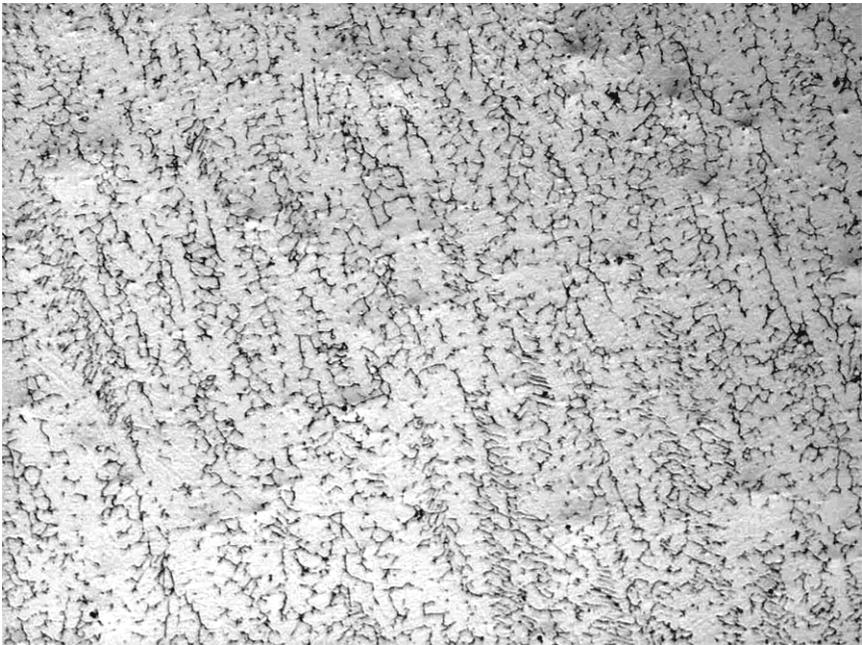
48X



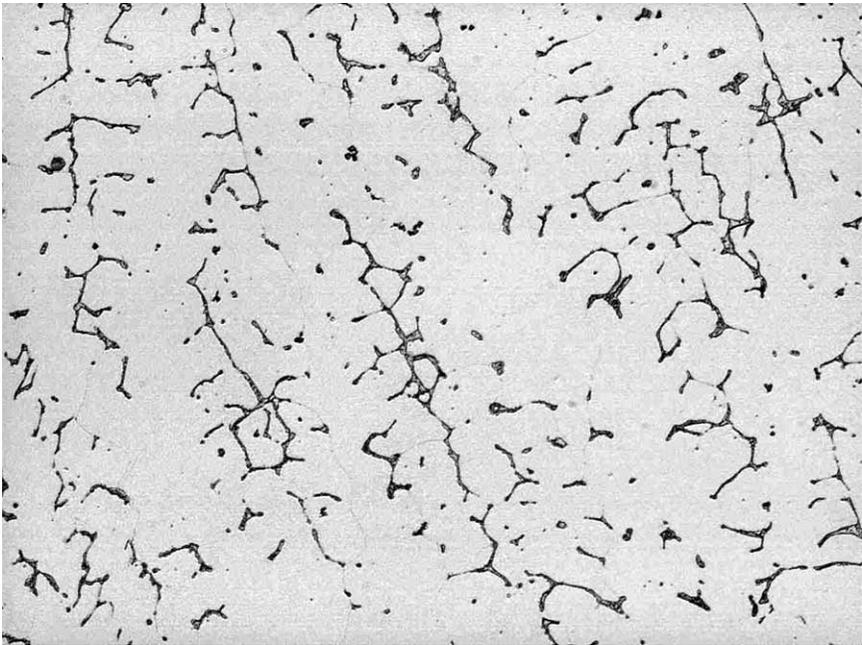
Etched

48X

Figure 6.1.1.3: Micrographs showing the deepest crack observed in A2A7M. Fine intergranular or interdendritic cracks emanating from the crack tip are visible. The crack tip is estimated to be approximately 0.057" (1.47 mm) below the surface. The cracks in the above two photos are the same, but are shown at slightly different planes due to re-polishing.



100X



375X

Figure 6.1.1.4: Typical clad microstructure in the mid-thickness of the cladding.