



Figure 57: OD of bolt 120°-6 near 45°, 50X



Figure 58: Center of Figure 57, 500X

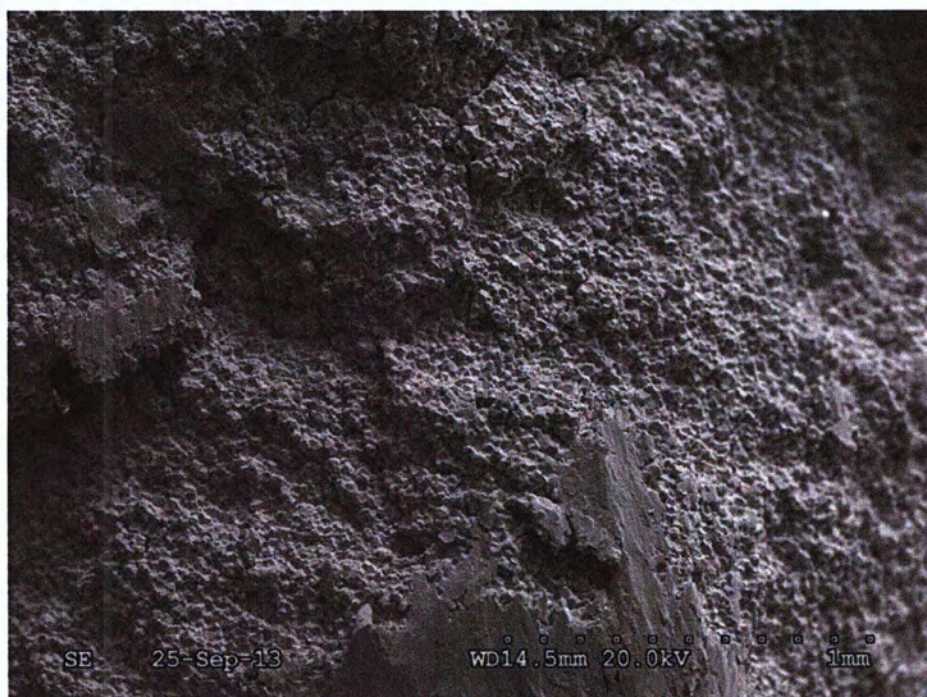


Figure 59: Mid-diameter of bolt 120°-6, 50X

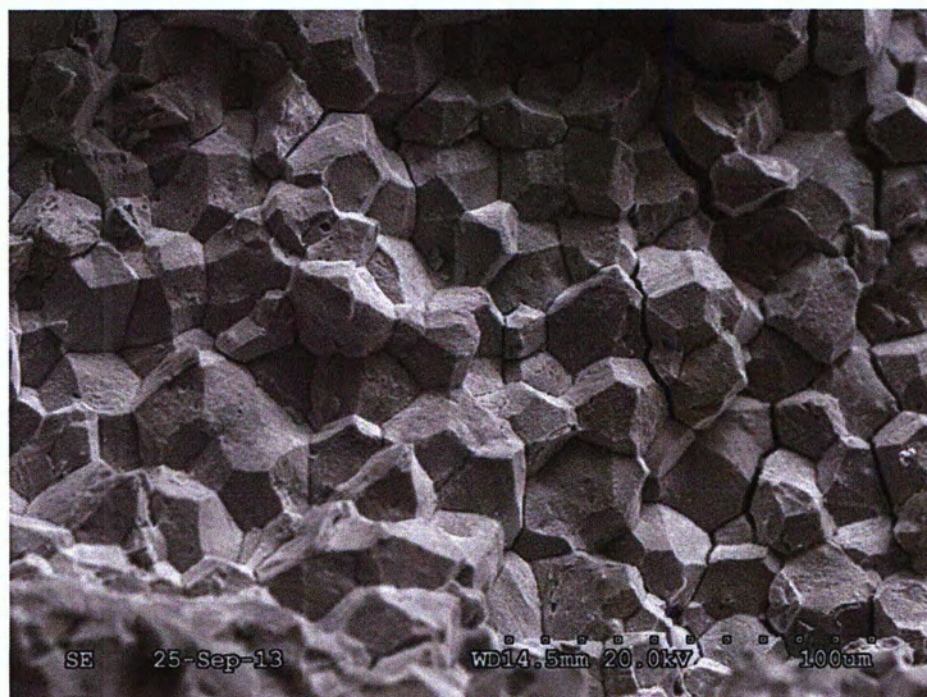


Figure 60: Center of Figure 59, 500X



Figure 61: Center of 120°-6 fracture, 50X

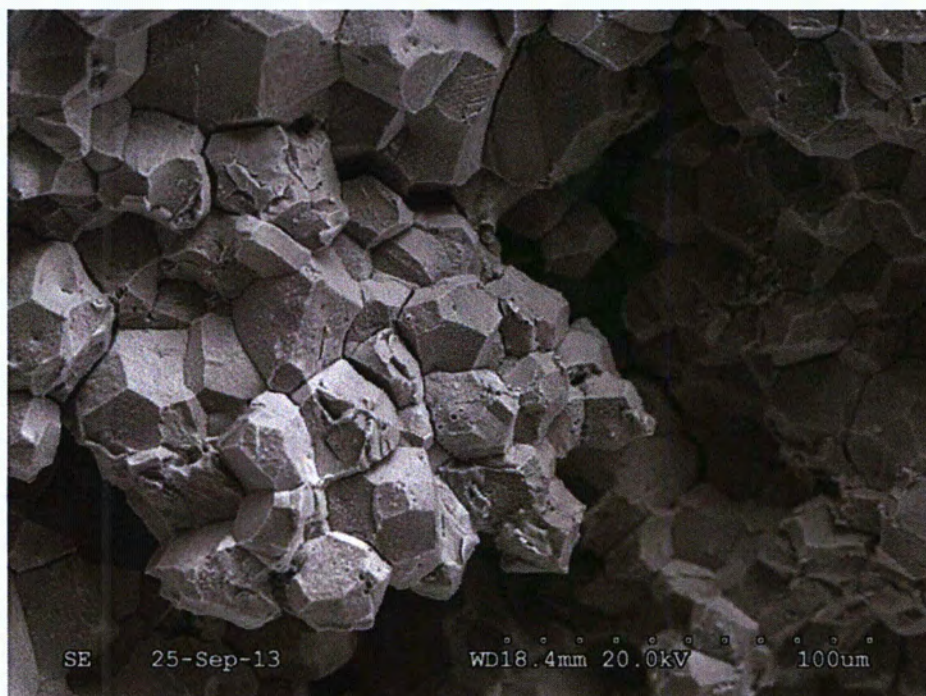


Figure 62: Center of Figure 61, 500X

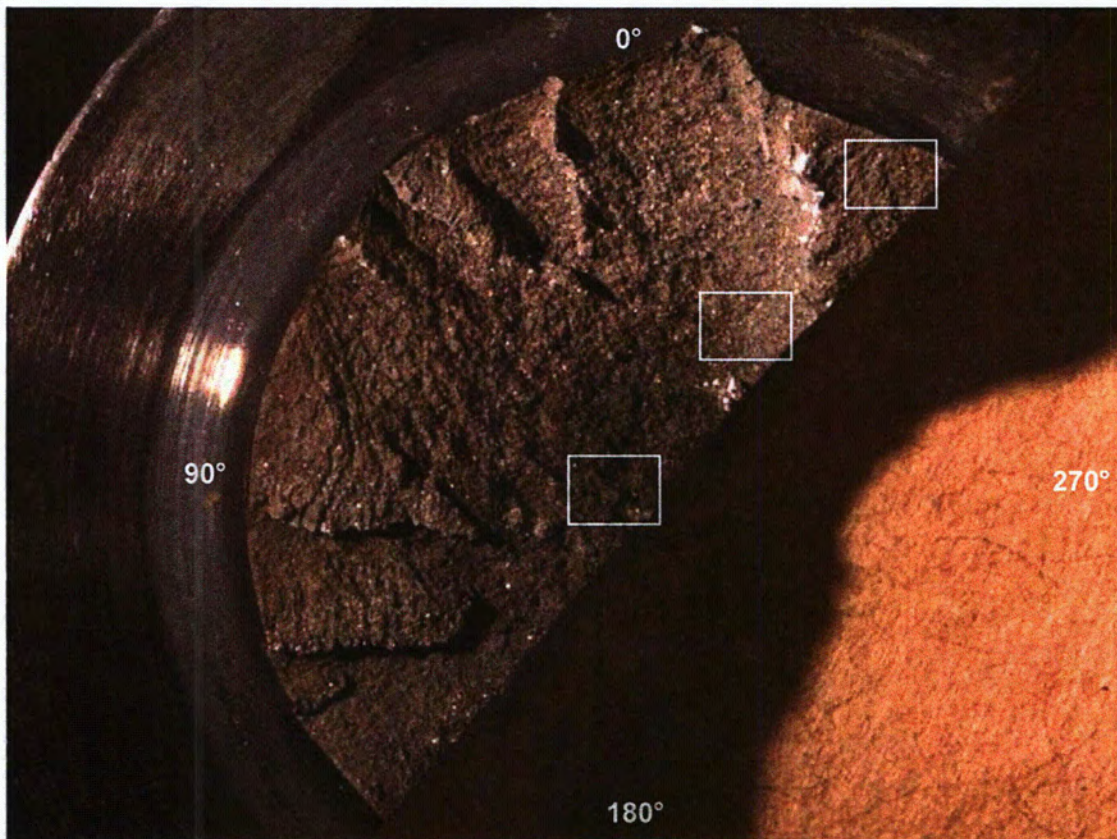


Figure 63: Stereo microscope photograph showing the open crack surface for bolt 240°-7. The areas within the white rectangles are shown at higher magnification in the following figures. 6X



Figure 64: OD of bolt 240°-7 near 315°, 50X

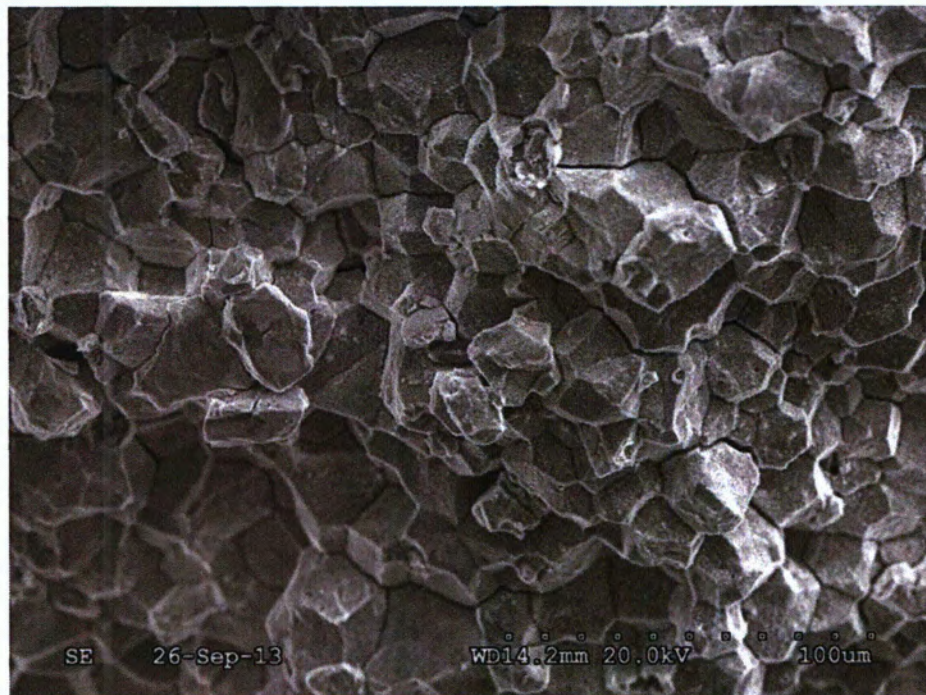


Figure 65: Center of Figure 64, 500X



Figure 66: Mid-diameter of 240°-7, 50X

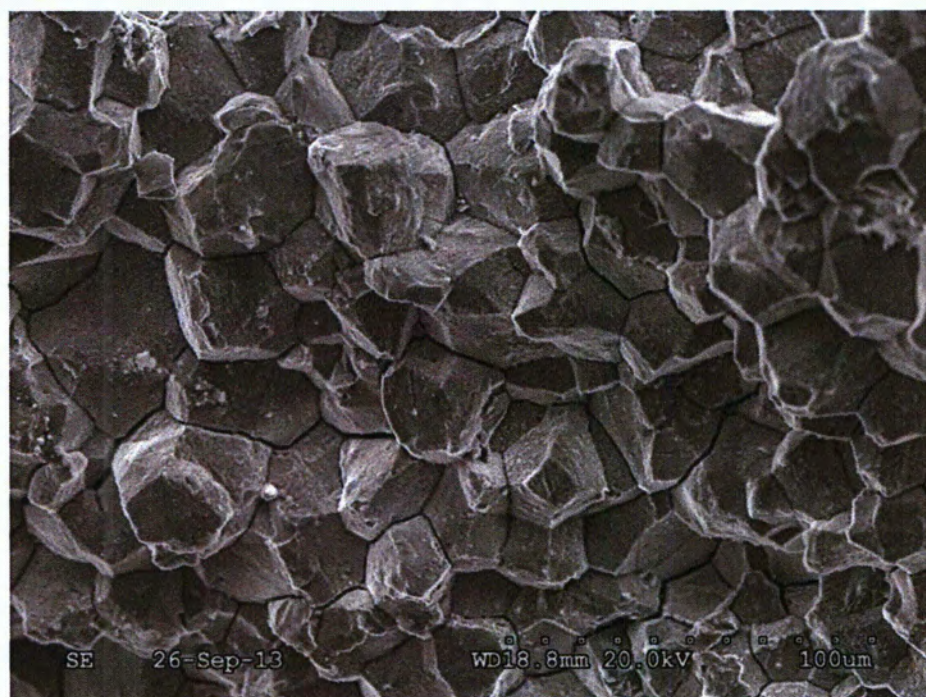


Figure 67: Center of Figure 66, 500X

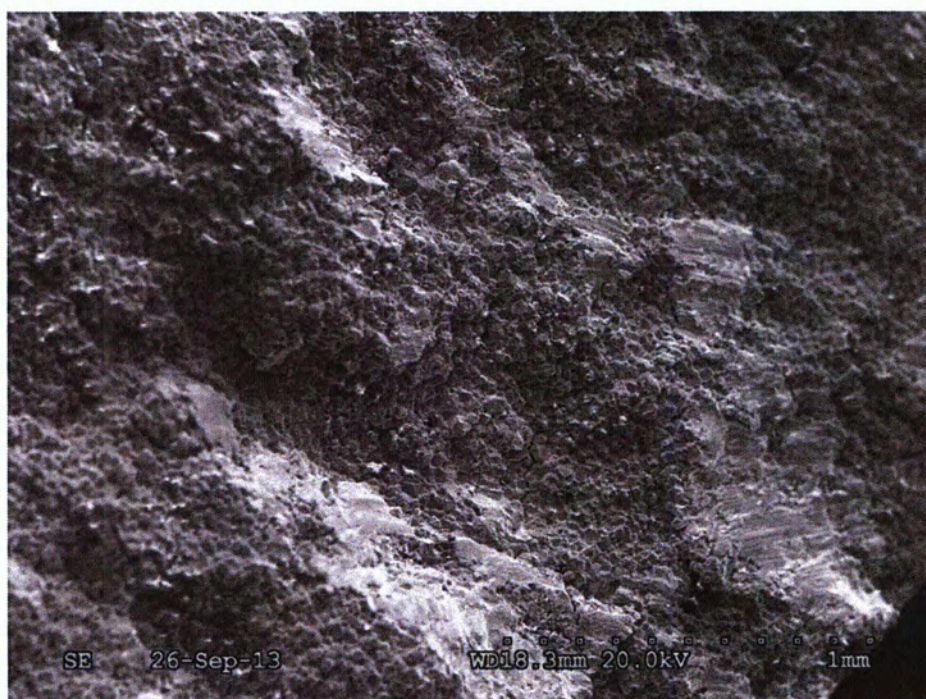


Figure 68: Center of 240°-7 fracture, 50X



Figure 69: Center of Figure 68, 500X

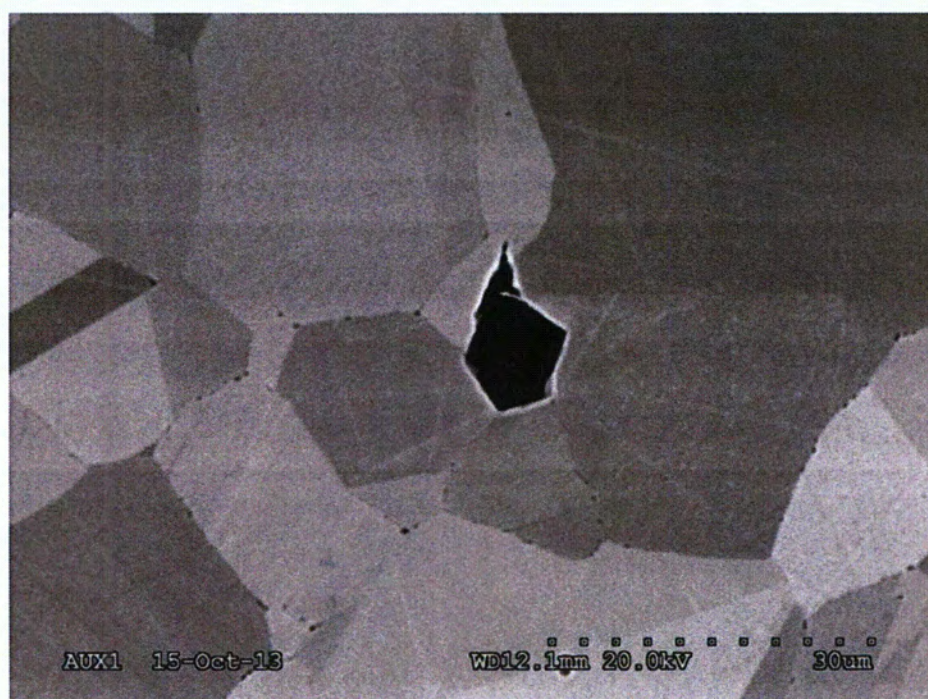


Figure 70: BSE image of titanium nitride ~15 μm in size, 1,500X

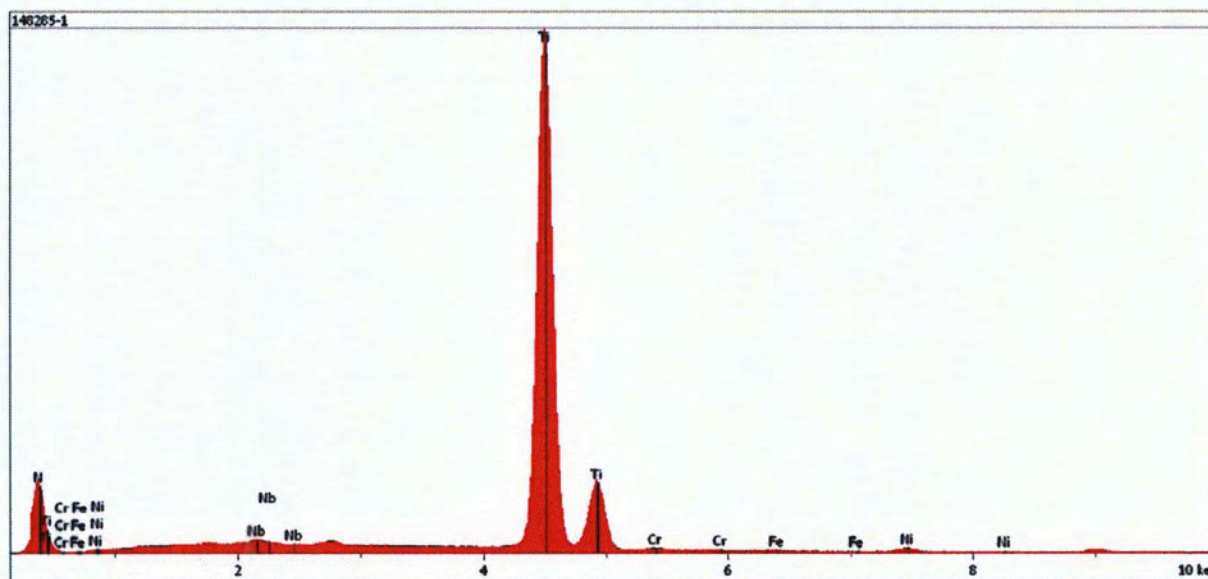


Figure 71: EDS spectrum collected from precipitate shown in Figure 70 above. Primary elements detected included titanium, nitrogen, and trace amount of nickel and niobium.

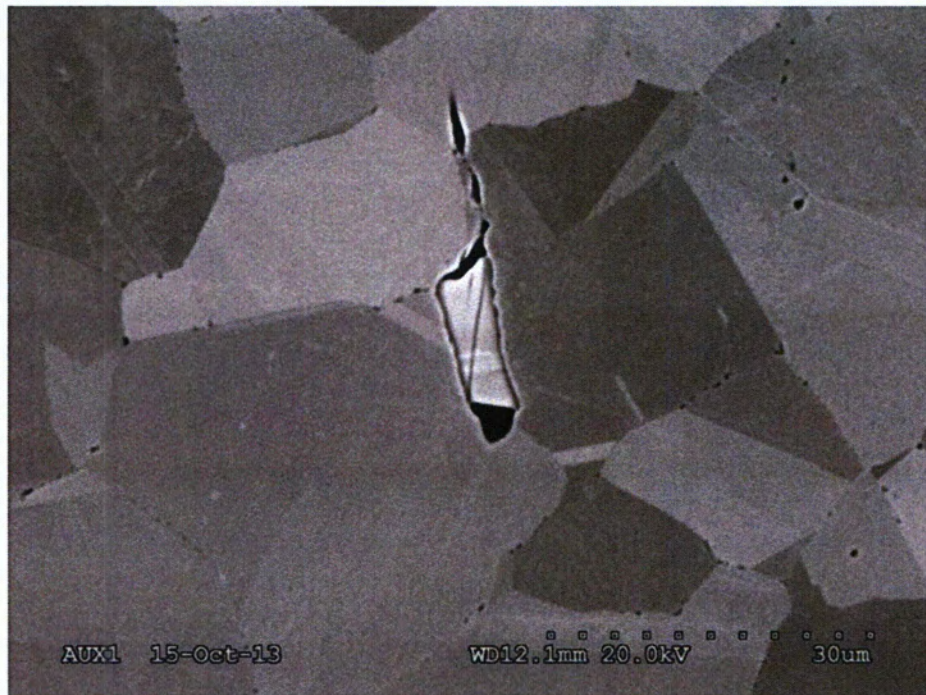


Figure 72: BSE image of niobium-titanium intermetallic ~20 μm long, 1,500X

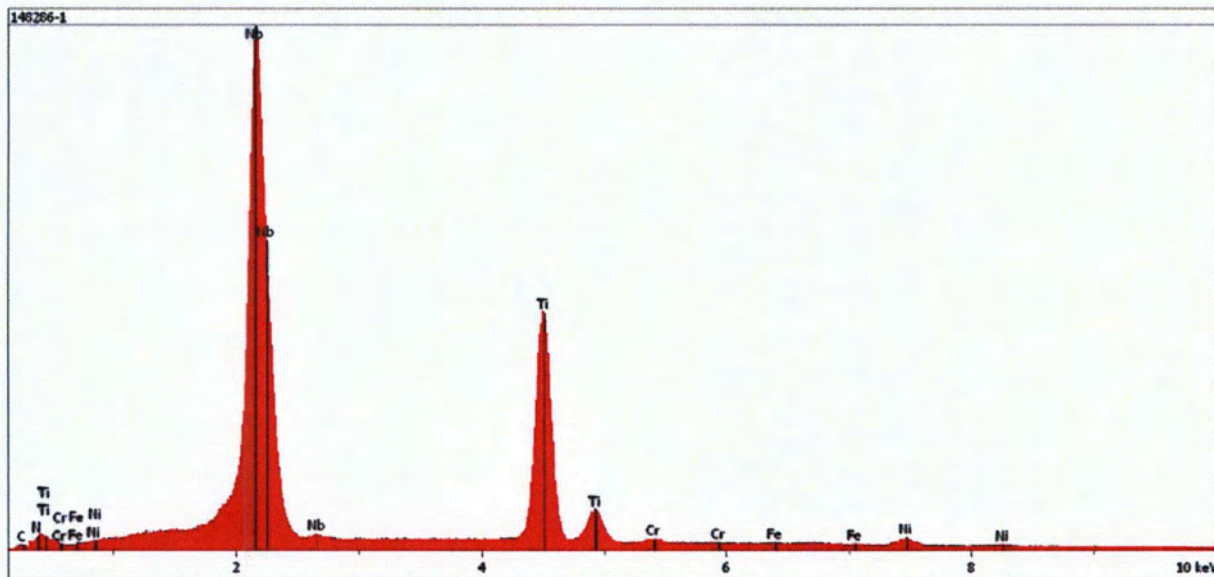


Figure 73: EDS spectrum collected from precipitate shown in Figure 72 above. Primary elements included niobium and titanium; trace levels of iron, chromium, and nickel were also present.

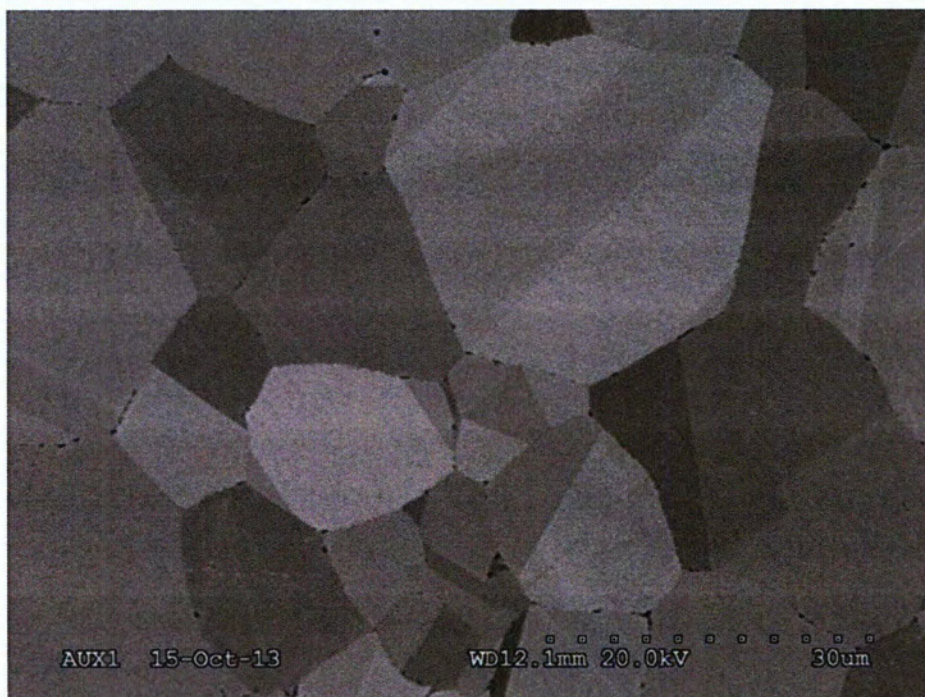


Figure 74: Typical area of polished cross section, 1,500X

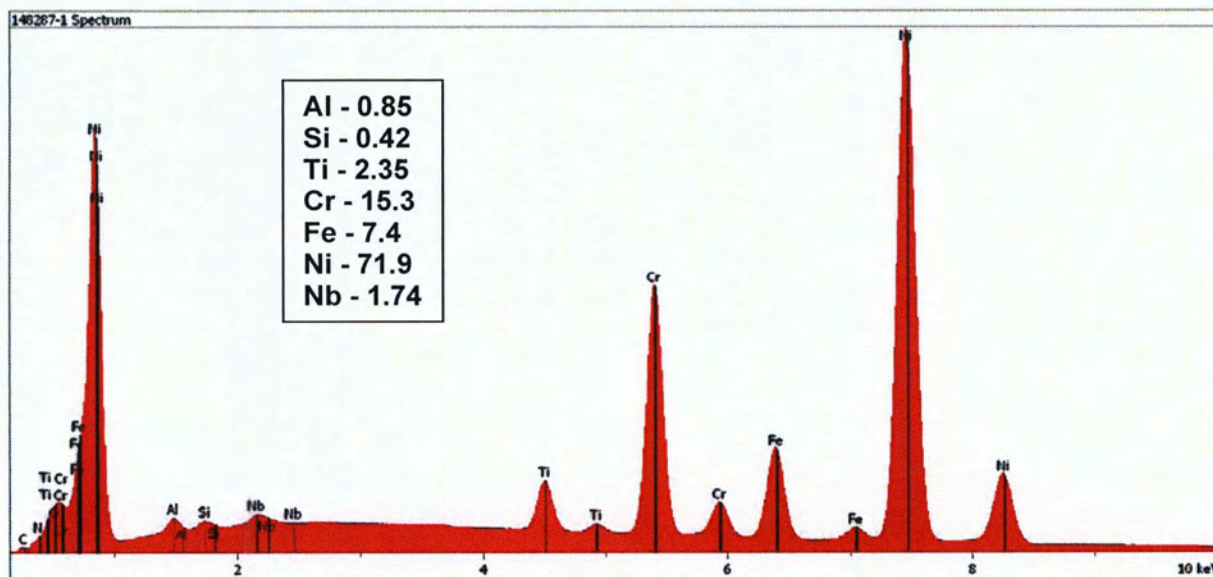


Figure 75: EDS spectrum collected from entire area shown in Figure 74. The quantitative results (inset) were generally consistent with nominal X-750.

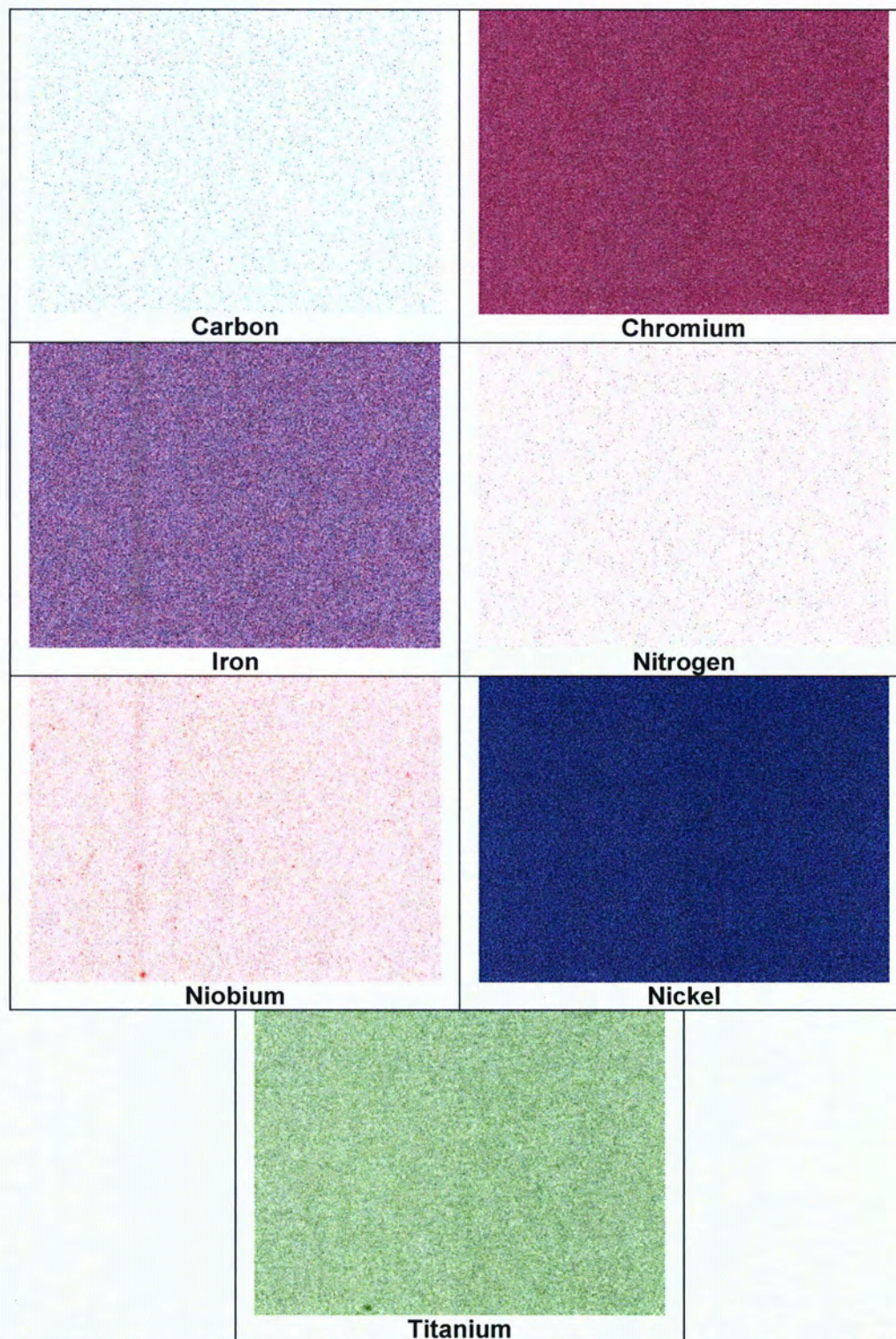


Figure 76: EDS dot maps collected from area shown in Figure 74. Primary constituents are nickel, chromium, and iron, as expected. Trace amounts of titanium and niobium were detected at discrete points as well. Carbon was not detected.



Figure 77: Tensile fracture surface for 240°-7L4, 80X

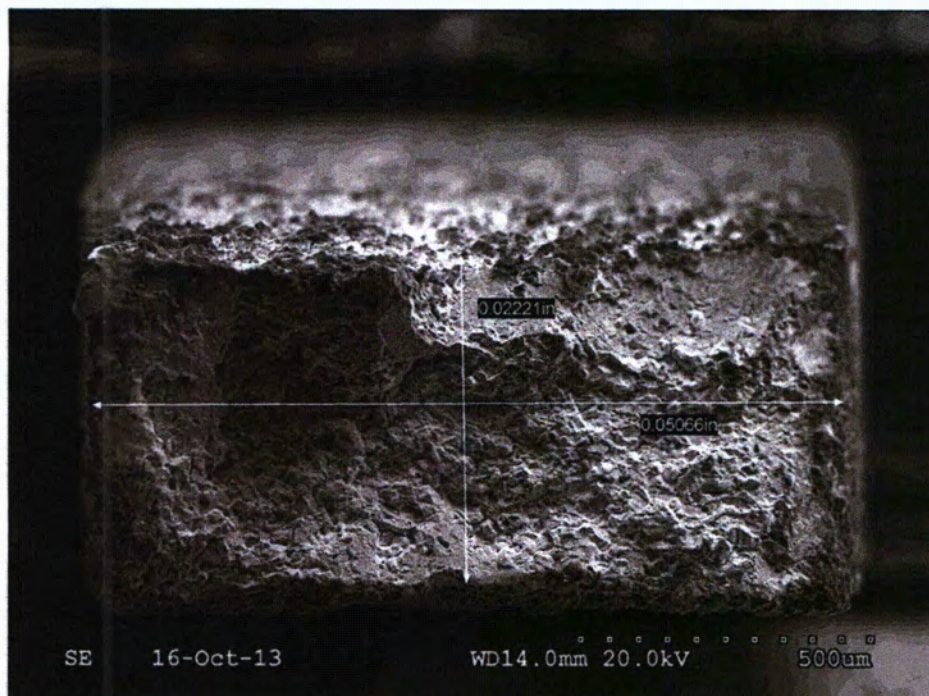


Figure 78: Same micrograph as Figure 77 annotated with reduction in area measurements, 80X

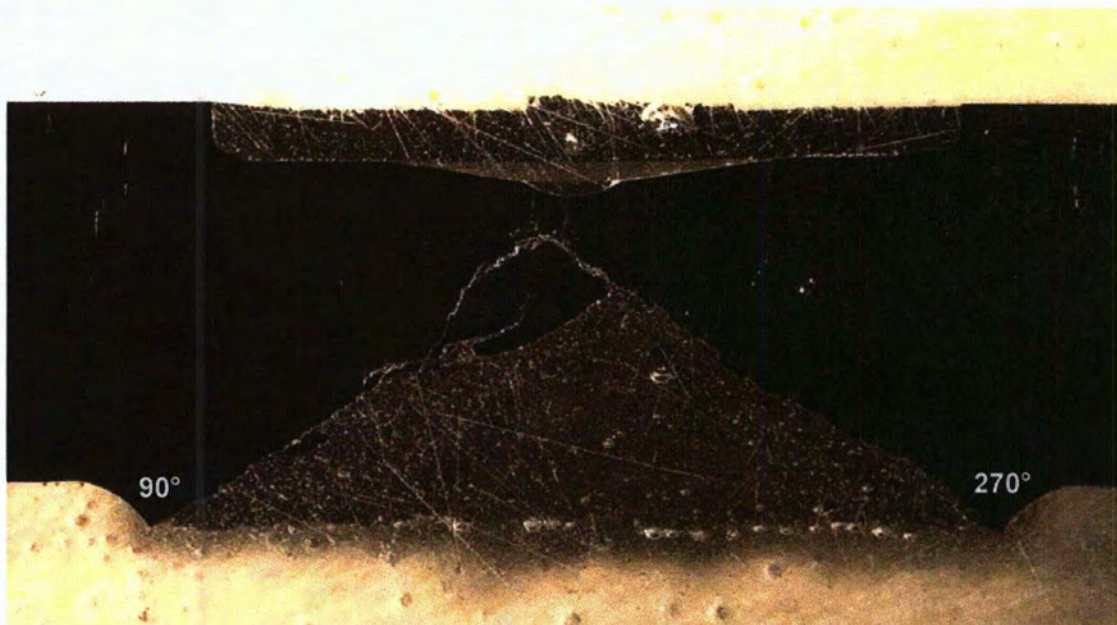


Figure 79: As-polished overview of bolt 120°-2 cross section. 6X

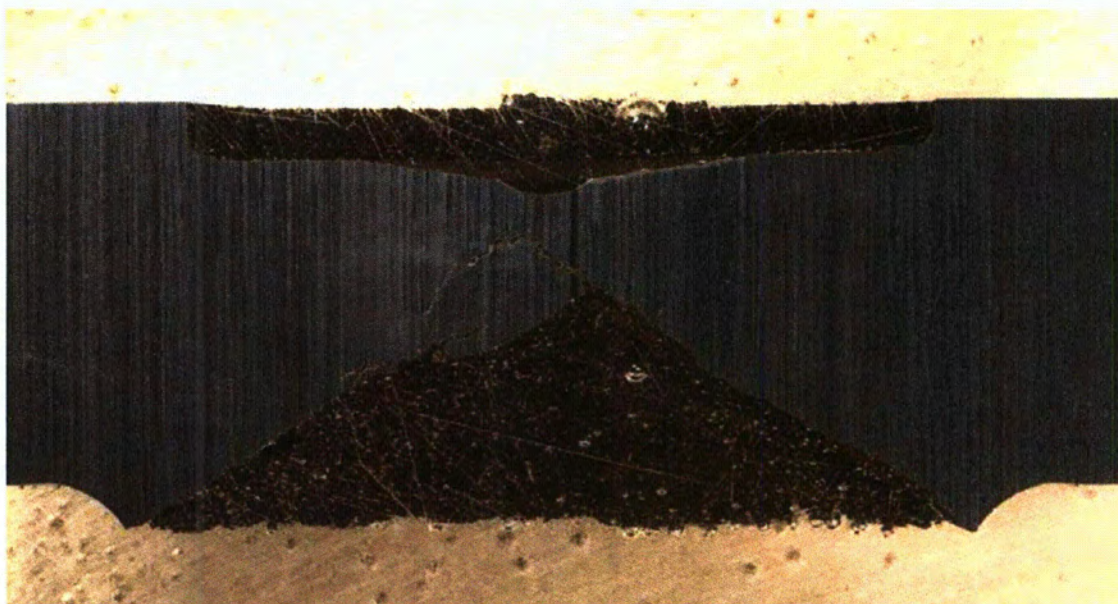


Figure 80: Same area as Figure 79 after phosphoric + nital etch. Structure is banded, as evidenced by the presence of vertical streaks. 6X

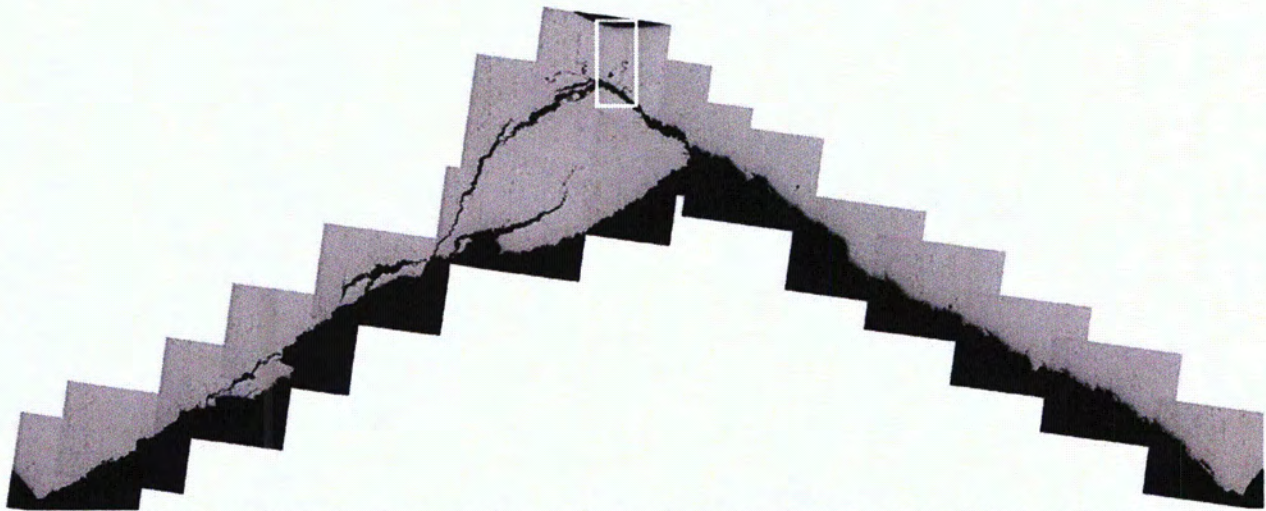


Figure 81: As-polished micrograph montage of crack. Area inside white box is shown in Figure 82. ~10X

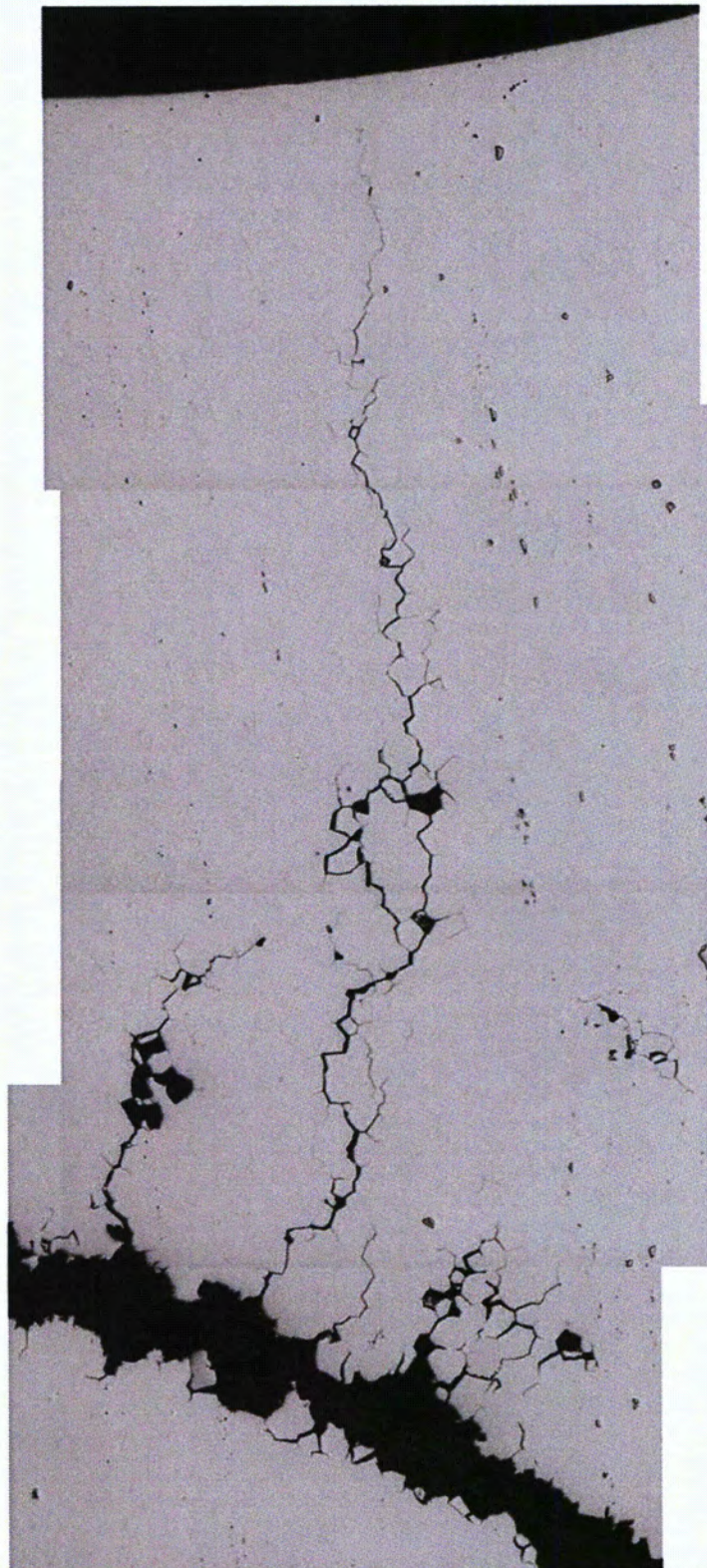


Figure 82: Higher magnification detail of Figure 81, as-polished. 140X

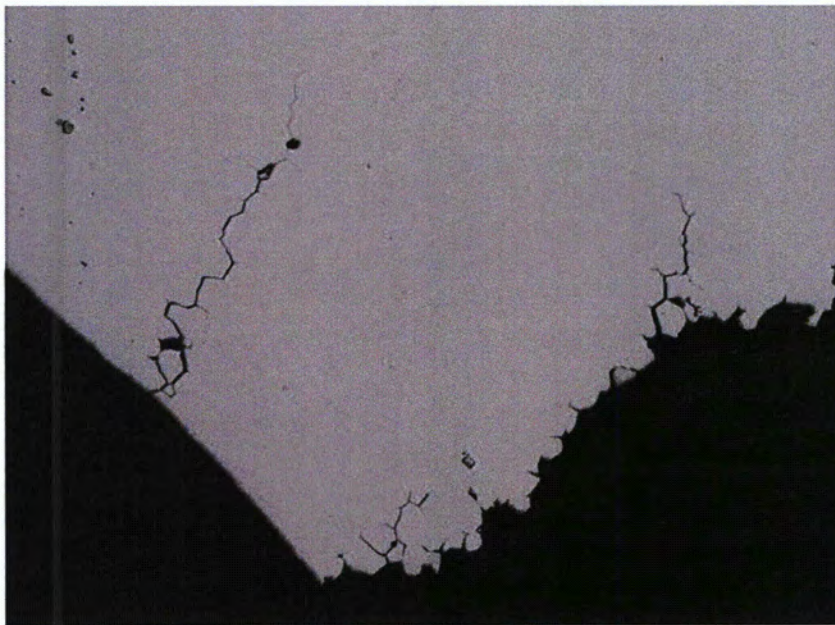


Figure 83: Detail of initiation near 90°. 180X



Figure 84: Same area as Figure 83 after phosphoric + nital etch. 180X



Figure 85: Detail of initiation near 270°. 180X



Figure 86: Same area as Figure 85 after phosphoric + nital etch. 180X

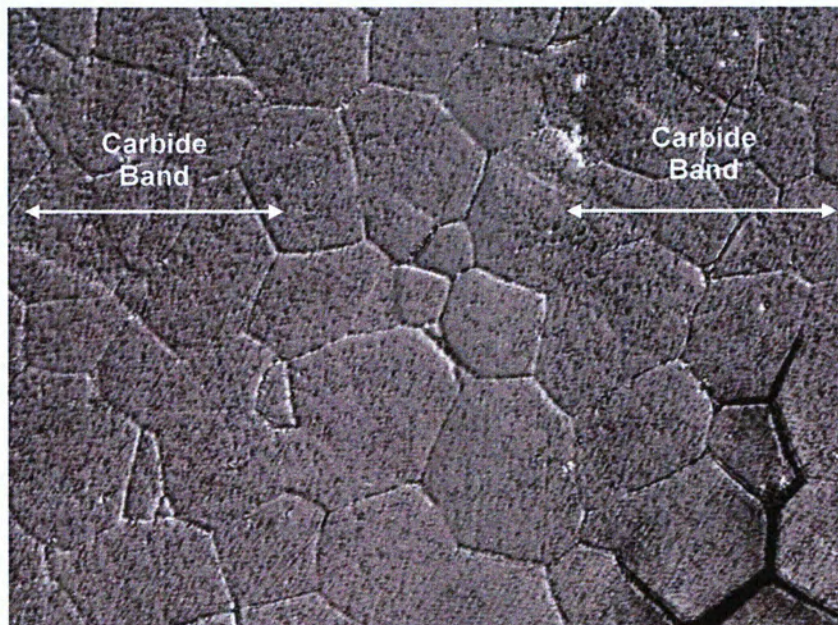


Figure 87: Typical microstructure after phosphoric etch, DIC, 660X.



Figure 88: Same area as Figure 87 after phosphoric + nital etch, DIC, 660X.

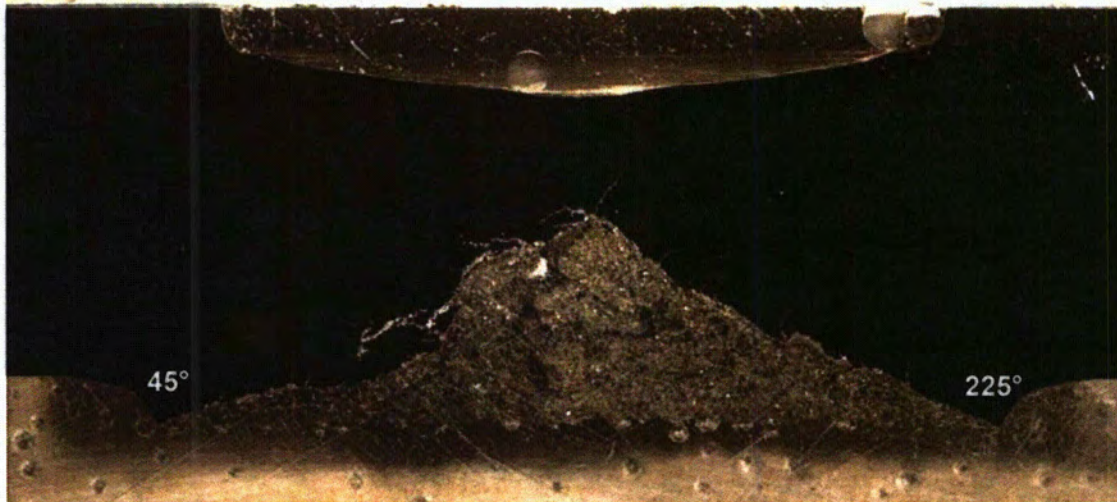


Figure 89: Bolt 120°-6 cross section as-polished overview. 6X

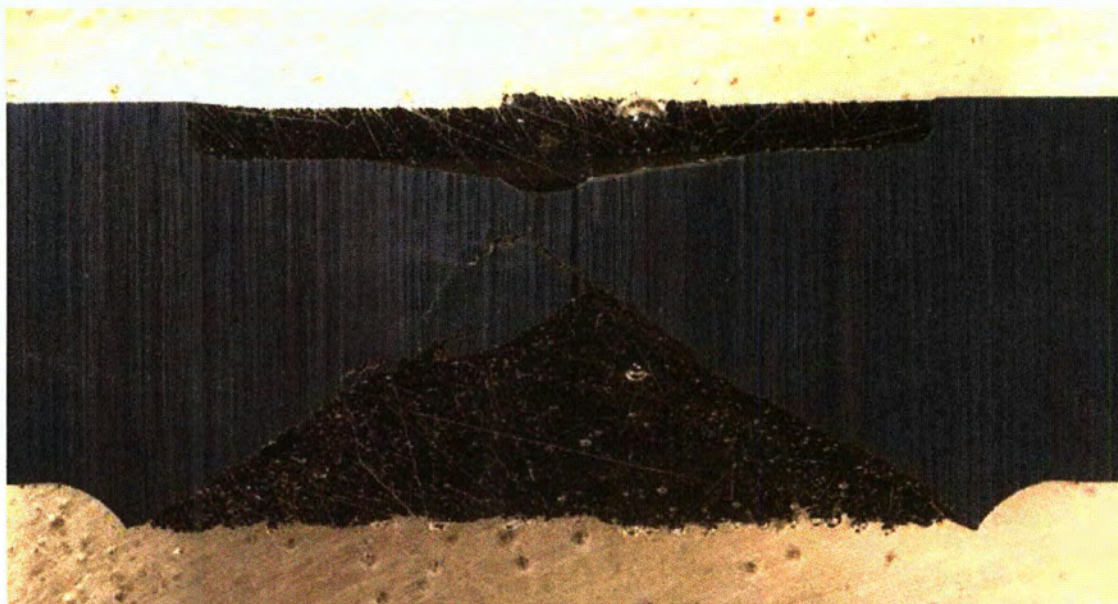


Figure 90: Same area as Figure 89 after phosphoric + nital etch. Structure is banded as evidenced by the presence of vertical streaks. 6X

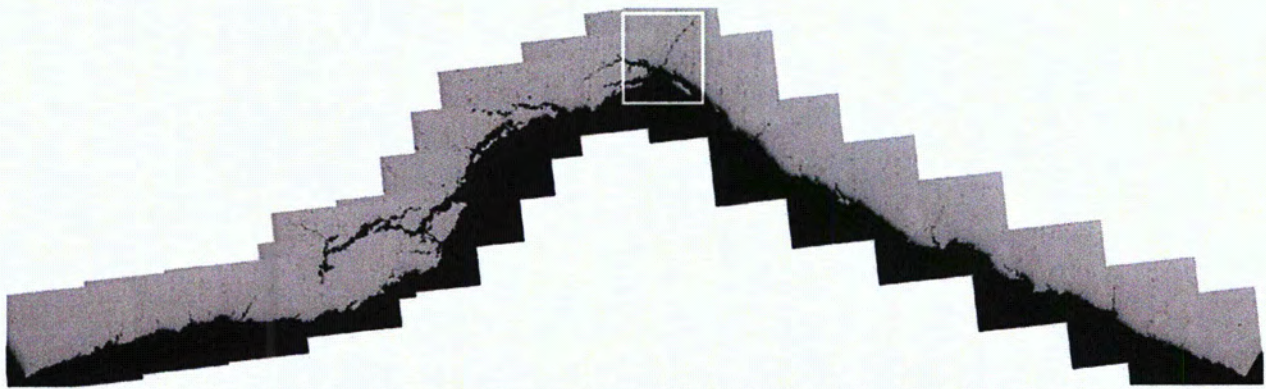


Figure 91: As-polished micrograph montage of crack. Area inside white box is shown in Figure 92. ~10X

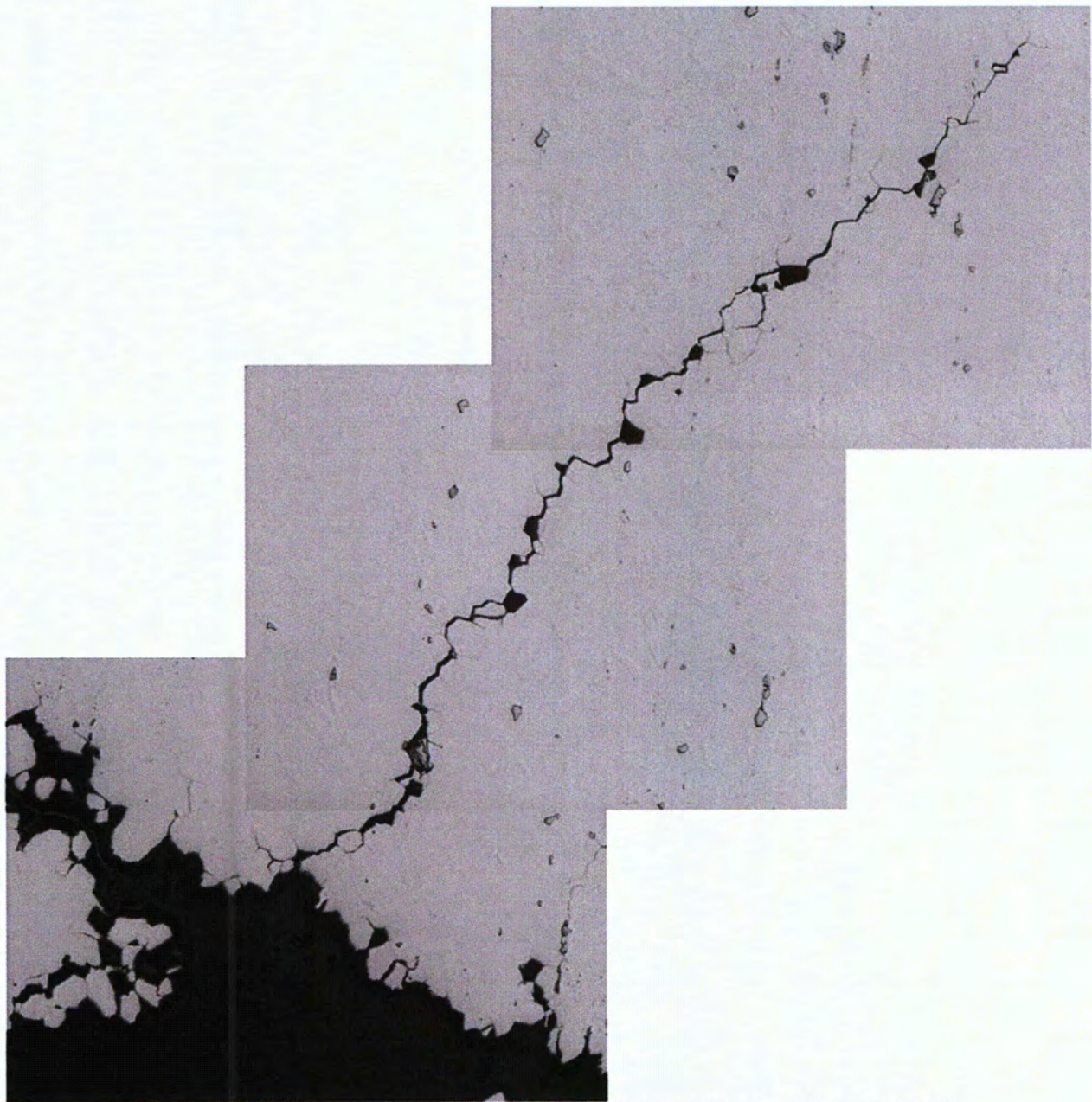


Figure 92: Higher magnification detail of Figure 91, as-polished. 140X