

Grain Flow Pattern For Bolts, Screws, And Studs

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1. SCOPE

This specification covers the grain flow pattern requirements in headed bolts, screws, and studs. The heading practice in the manufacture of the bolt, screw, or stud sets the grain flow pattern, but it is also greatly influenced by the fastener and tooling design as well as cold-forging setup. The use of tooling design simulation software is recommended and a commonly used practice that provides reliable forging predictions for superior grain flow quality.

2. TEST PROCEDURE

- 2.1 After heat treatment the determination of the acceptability of grain flow is very subjective, therefore, testing for grain flow shall be performed after initial heading, prior to heat treatment, and subsequent processing of parts and shall be used as primary manufacturing inspection method.
- 2.2 Changes in design or processing that affect grain flow pattern require reverification. Those include but are not limited to: Tool or die changes, material or wire changes. Parts should be re-verified in any instance where those changes occur.
- 2.3 The head and shank shall be sectioned approximately on the centerline, with the shank having a minimum length of 1.0 X the diameter of the shank.
- 2.4 Macroetch the sectioned head and shank sufficient to reveal the grain flow pattern, using etching practice based upon ASTM E340, and shown in the manufacturer's control plan. Grain flow samples shall be viewed at sufficient magnification to allow for adequate resolution of the grain flow lines.

NOTE: After etching, a light "reveal" polish on a diamond wheel has the effect of knocking back some of the raised areas on the flow line ridges. This process improves the contrast between the darker root of the etch flow line, and the lightened or polished crests to improve evaluation.

3. GRAIN FLOW PATTERN REQUIREMENTS

- 3.1 Grain flow throughout the product shall be continuous and uninterrupted except in those instances where a flash trim line has been determined to be acceptable. A continuous and uninterrupted grain flow must be maintained around the fillets and radii, but may be compressed. Grain flow lines terminating in head to shank fillets, radii, or onto the shank surface are not acceptable. In upset parts, the entire material compression zone in the head shall be above the head to shank radius. Figures #1, #2 and #3 show the acceptable grain flow pattern typical in flange heads. Figures #4 and #5 show the unacceptable grain flow pattern typical in flange heads for comparison. All Figures represent a flange headed product. However, the grain flow principles and requirements apply to all head shapes. Figures 6 and 7 show the acceptable grain flow of recess drive part. Figures 8 and 9 show unacceptable grain flow in recess drive parts.

NOTE: The compression zone is the flow of material grain created during forging. These are the compacted flow grains of the base metal and flow through the part shape created during forging. The entire compacted grain flow zone shall be at or above the bearing surface as this zone contains the greatest internal stresses that can lead to poor manufacturing and part performance.

4. REFERENCES

ASTM E340.

5. KEY WORDS

End Grain, Compression Zone, Grain Flow.

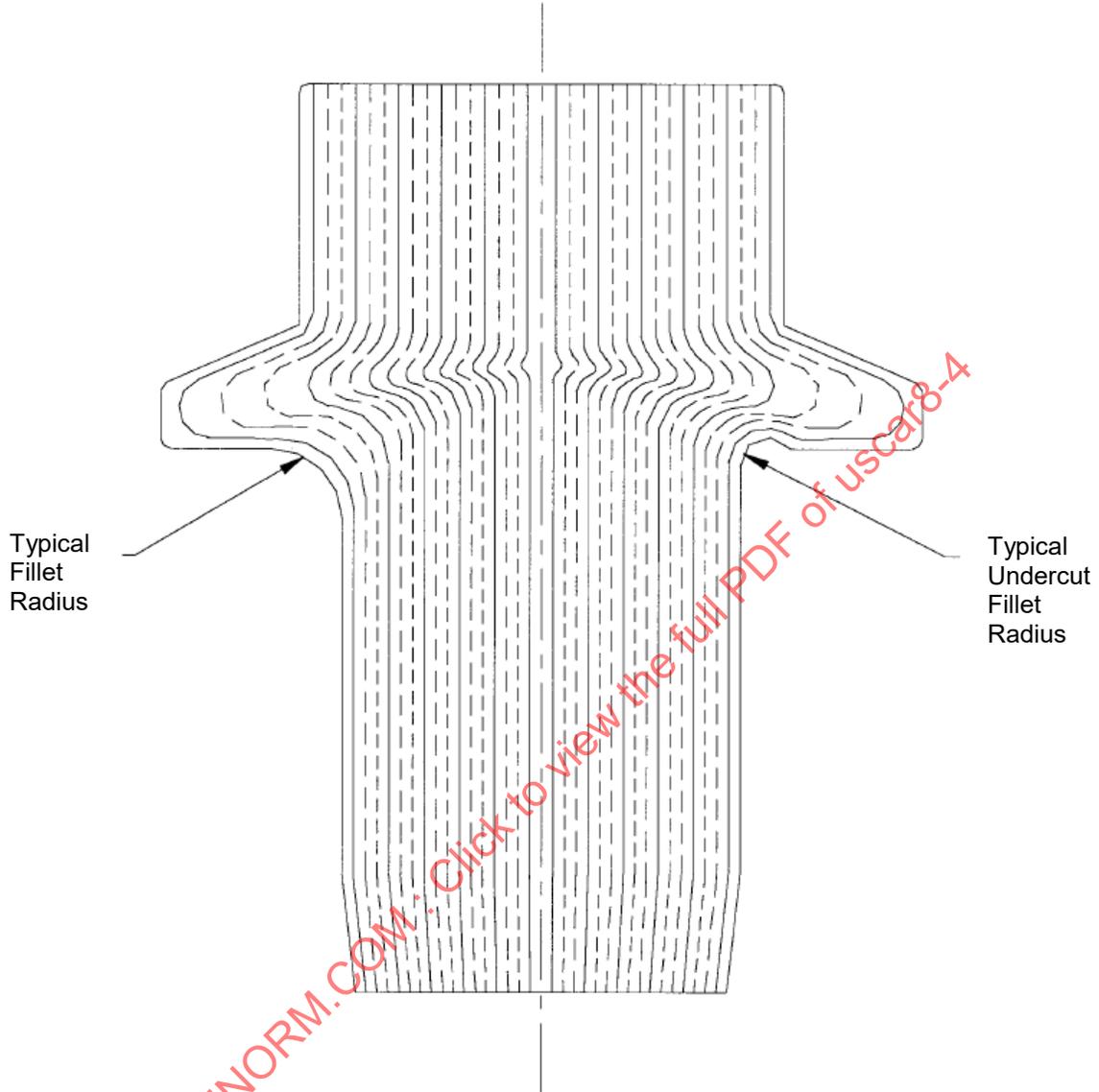


Figure 1 - Acceptable grain flow pattern

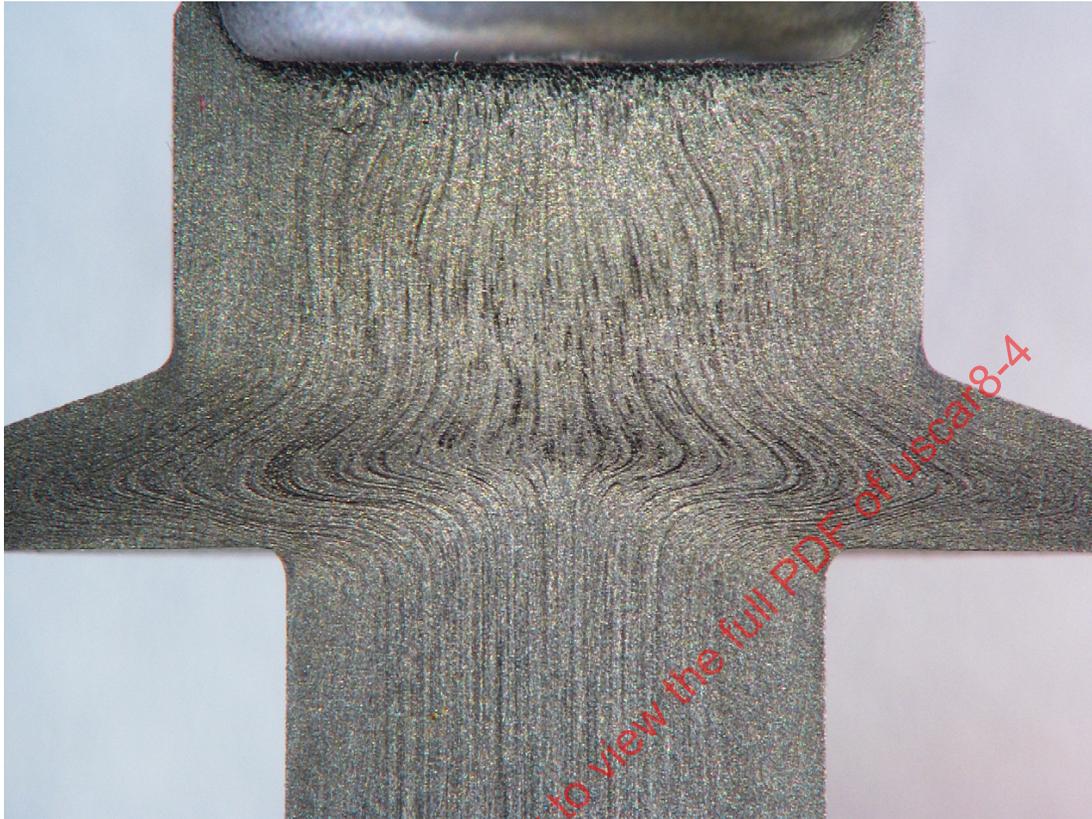


Figure 2 - Acceptable grain flow photograph

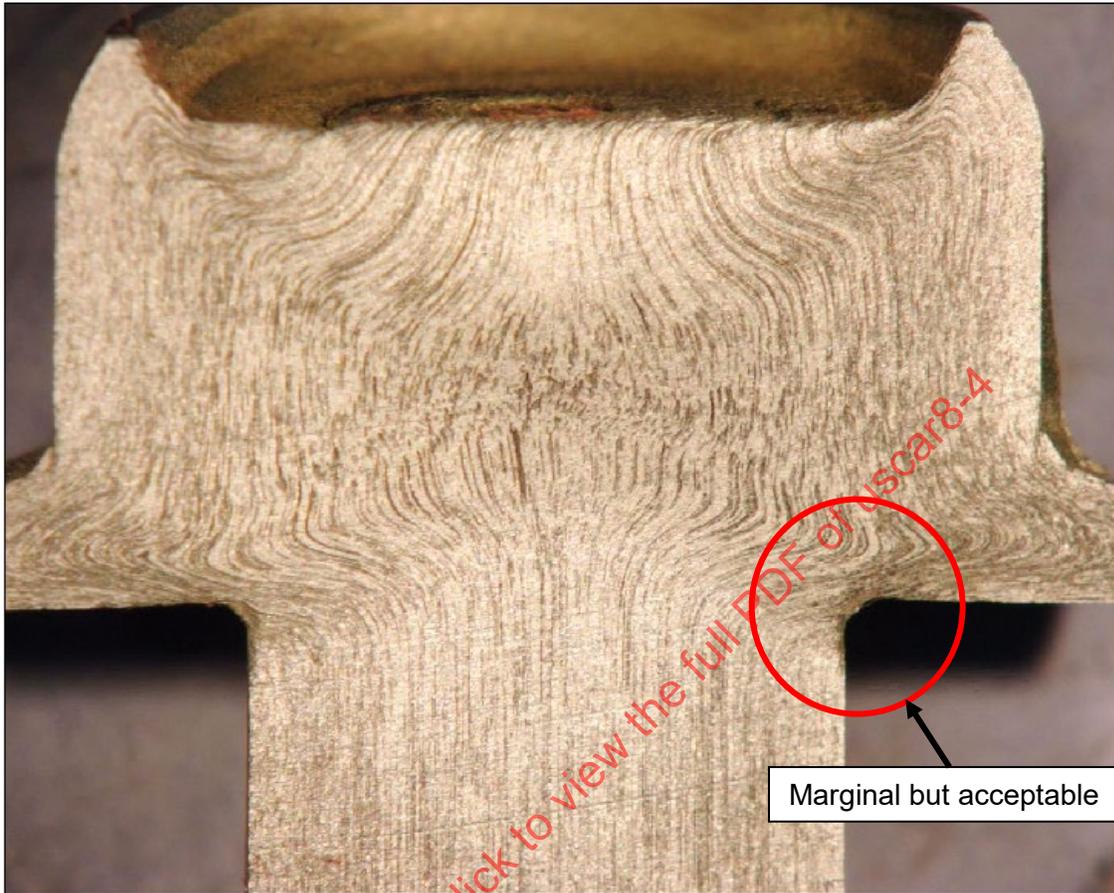


Figure 3 - Marginally acceptable grain flow photograph

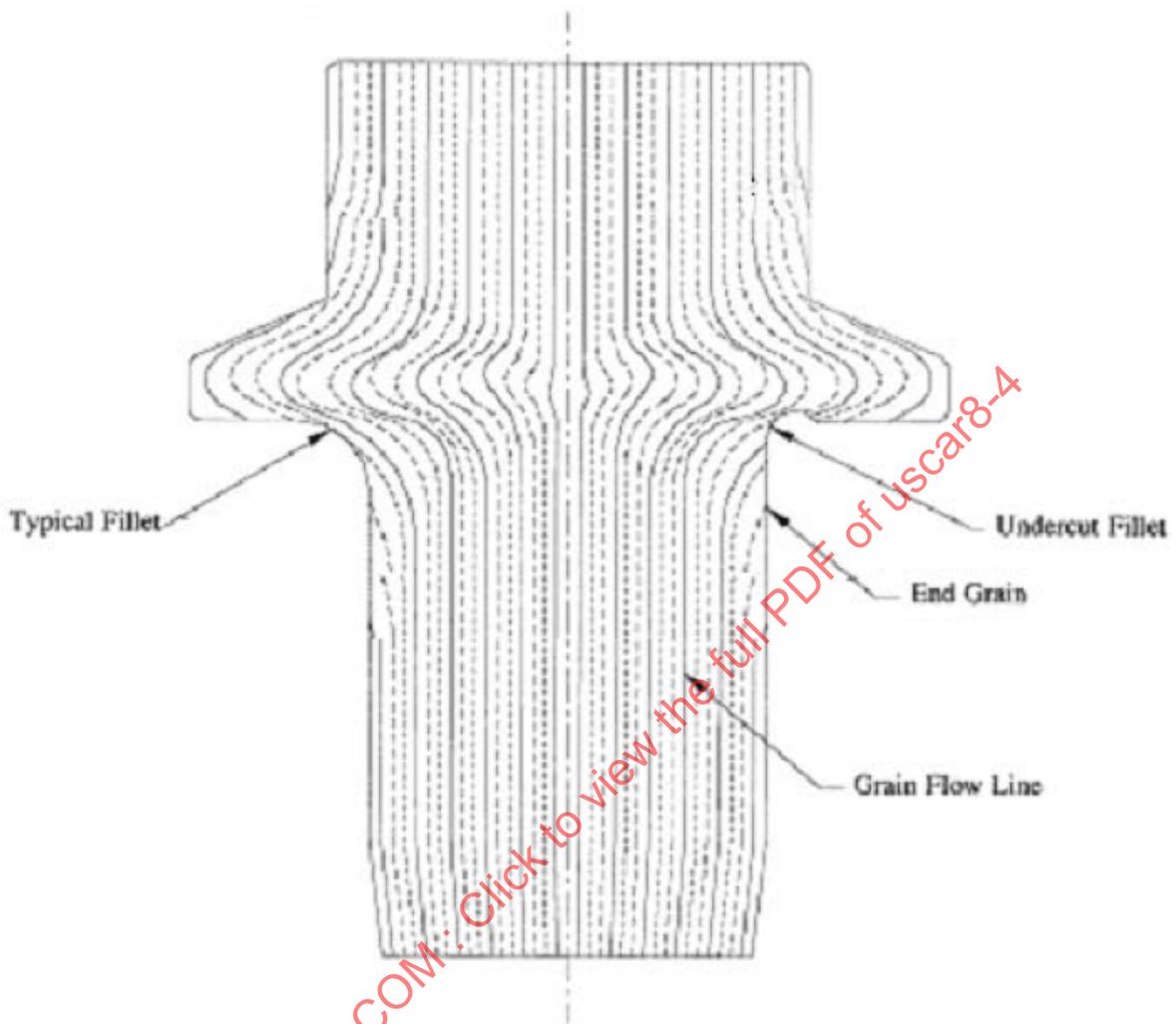


Figure 4 - Unacceptable grain flow pattern



Figure 5 - Unacceptable grain flow photograph

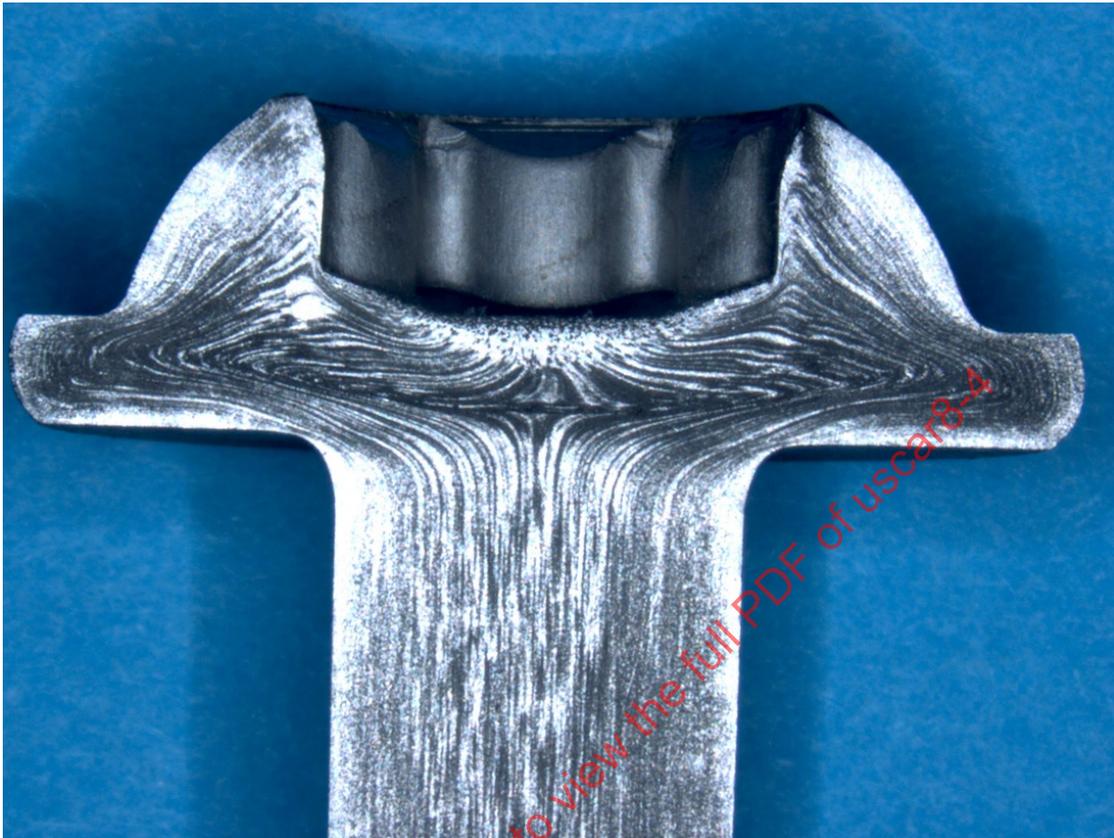


Figure 6 - Acceptable grain flow in recess drive part types

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Figure 7 - Acceptable grain flow in recess drive parts

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