Metallurgical Failure Analysis of 420SS Brake Rotor

Metallurgical Testing

The fracture area of the rotor was photographed and a section of that fracture was prepared in accordance with standard ASTM procedures for microhardness and microstructure analysis. The microstructure was delineated with Kalling’s etch for optical examination: it is a very fine normal appearing martensitic microstructure with no indications of overheating or grain growth. The grain size is much finer than ASTM 8. The hardness was measured using a calibrated Tukon microhardness tester: it is ~50 HRC. The rotor and mounted section are shown in Figure 1.

Conclusion

The cause for the fracture is most likely due to a lack of ductility because of a very fine measured grain size. The microstructure has not been overheated, thermal processing nor by abrasive wear during use. SEM examination of the fracture surface is highly recommended.

Discussion / Recommendations

In order to obtain more desired performance from material at hand, I would recommend tempering these parts to a much lower hardness; i.e. 35 to 45 HRC; with preference toward lower end. This recommendation to perform a higher tempering heat treatment will serve to reduce the tendency to crack.

The rotor is being fabricated from 420 SS metal plate which has undergone severe “mill” processing. This means the material was mill processed to reduce the cross-section, which resulted in a refined grain microstructure with cold plastic deformation. A 420SS, with an extremely refined grain structure will not behave in a ductile manner when stressed has a tendency to be rather brittle when hardened at 50 HRC or above. The amount of mechanical reduction required to size the metal into the cold worked condition directly effects the mechanical properties downstream. Hardening heat treatment will usually not increase the grain size. If this material could be ordered specifying not more than 15% cold reduction; along with a grain size not to exceed ASTM 6; the performance from a fracture resistance standpoint would be enhanced.

Respectfully Submitted,

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FIGURE 1. FRACTURED ROTOR and MOUNTED SECTION.

Kalling's etch was used to delineate the microstructure for optical examination and grain size measurement. Grain size is finer than ASTM 8. No anomalies were observed.