Sintered, Highly Wear-Resistant Material for Turbochargers

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1 Abstract

From the viewpoint of improving fuel economy and regulating the exhaust gas of internal combustion engines, the boarding rate of turbochargers in passenger cars is increasing, in particular, for gasoline vehicles, where the boarding rate exceeds that of diesel vehicles.[1)-4)] In gasoline engines, because the temperature of exhaust gas released by turbochargers becomes quite high, austenitic high-chromium cast steel (hereinafter “high-chromium cast steel”), which has high wear-resistance and oxidation-resistance, is generally used for the heat-resistant bearings that control the flow rate of exhaust gas. However, as a result of the application of technologies to improve fuel economy (such as lean-burn engines), the temperature of exhaust gas now rises to near 1,273 K, precipitating the need for further wear resistance. To address this need, we developed a highly wear-resistant sintered alloy that consists of fine carbide dispersed in an austenitic stainless steel matrix, and takes advantage of the flexibility of the alloy designs characteristic of sintered materials.

2 Characteristics of the Product

- The material offers better wear-resistance and lower friction compared to high-chromium cast steel.
- The material offers the same level of resistance to oxidation as high-chromium cast steel.

3 Background of the Development

Sliding heat-resistant bearings are used in turbochargers to adjust the flow rate of exhaust gas. As such, these bearings must be highly resistant to both wear and oxidation. Conventionally, high-chromium cast steel has been used for these bearings. However, a problem where the rising temperature of exhaust gas led to bearings wearing down or becoming stuck, has prompted demand for even greater wear-resistance. In response to this demand and with the goal of breaking into the growing market for gasoline turbochargers, we began developing a sintered, highly wear-resistant material that offers better performance than high-chromium cast steel.

4 Technical Details

The material we developed uses an austenitic stainless steel matrix (Fe-Cr-Ni-Mo alloy), in which granular carbide is finely dispersed. **Figure 1** shows the microstructure of the material. The carbide-to-surface-area ratio of this material is about twice that of high-chromium cast steel. By using liquid phase sintering, we were able to achieve a high density of 7.3 Mg/m^3 and create a material that has isolated, fine pores. **Figures 2** and **3** show comparisons of the wear resistance and of the friction coefficient, respectively, between the new material and high-chromium cast steel. At 1,273 K, the amount of wear observed in the new material was approximately 30% of the amount of wear observed in the high-chromium cast steel, and the friction coefficient of the new material was lower and more stable than that of the high-chromium cast steel. These results can be attributed to the large number of fine carbide particles dispersed throughout the new material that help prevent adhesive wear. Similarly, **Figure 4** shows a comparison of the oxidation resistance between the two materials. The increase in the mass of the developed material due to oxidation is equivalent to that observed in the high-chromium cast steel, indicating that the new material has excellent oxidation-resistance. Main oxidation pathways lie in the chromium-depleted zones that form around pores and carbides, and the isolated, fine pores of the new material and the discontinuity of the chromium-depleted zone due to the pulverization of the carbide particles are believed to slow the progress of oxidation.[5)]

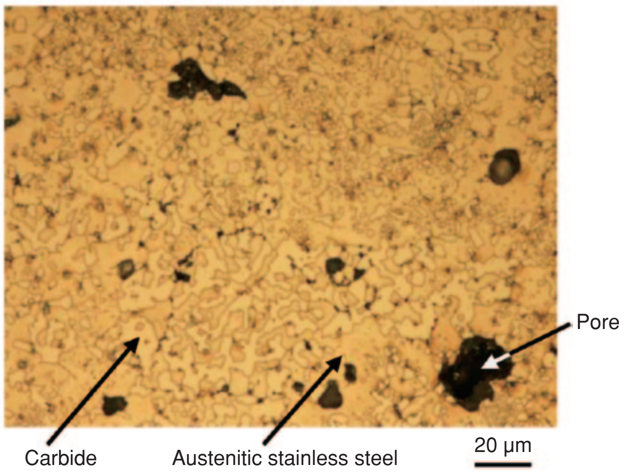

Figure 1 Microstructure of the developed material

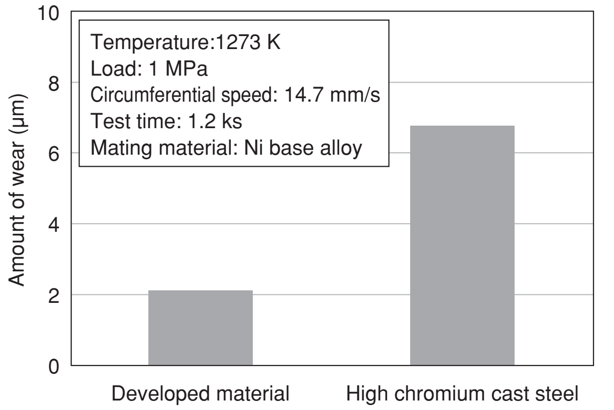

Figure 2 Results of the wear test

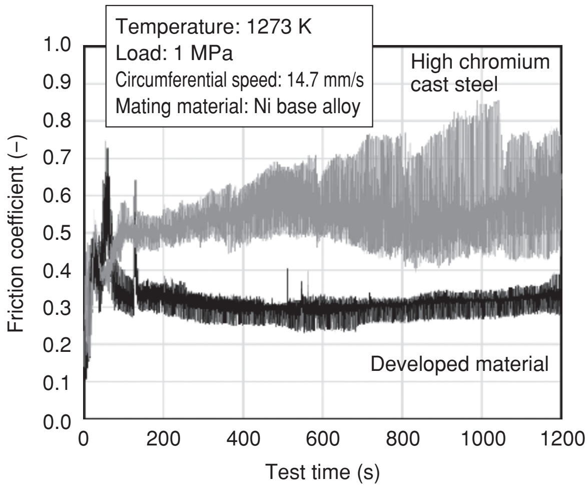

Figure 3 Friction coefficient during the wear test

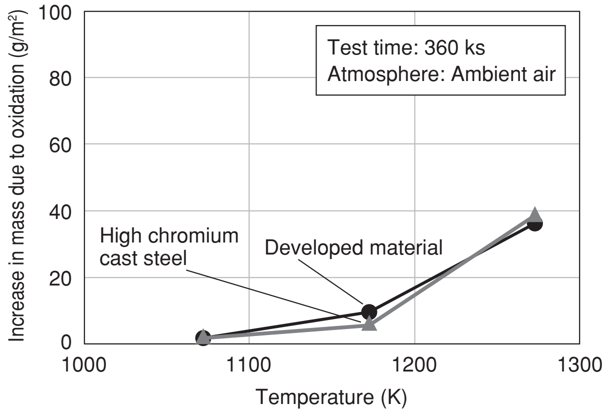

Figure 4 Increase in mass after the oxidation test

5 Future Business Development

Achieving high wear-resistance and high strength at high temperatures

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【Relevant patents】

Patent No. 5987284

Patent No. 5939384

Patent No. 6229277