# Sintered Heat Resistant Material for Turbochargers

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## 1 Summary

Recently, hybrid and electric vehicles have appeared on the market because of increasing environmental consciousness. However, gasoline engines and diesel engines are still expected to be used mainly for vehicles for several years. Under this situation, the turbocharger market has rapidly expanded because it enables engines to be downsized, which means a 20 - 50% reduction in the displacement of combustion engines. Since high wear resistance under high temperatures is required for turbocharger applications, heat-resistant wrought steels, such as high chromium (Cr) cast iron, have been used mainly in turbochargers. In contrast, sintered materials are regarded as insufficient heat resistant materials because they are porous. In this report, new high-Cr sintered material with heat and wear resistance superior to conventional wrought materials is described. The material was developed by both densification via liquid phase sintering and dispersion of fine particle shape carbides.

## 2 Features of Heat-Resistant Material for Turbochargers

- Pores are decreased by applying liquid phase sintering and preventing progression of oxidation to the interior of the material.
- Degradation of oxidation resistance is minimized while high resistance to abrasion is maintained.
- By including a large amount of Cr, passivation of oxidized layer is formed, granting high oxidation resistance.

## 3 History of Development

Components used in turbochargers are exposed to high-temperature exhaust gas and also slide against other components, so they require outstanding heat resistance and wear resistance. On the other hand, because sintered materials have pores internally, its heat resistance is inferior to, for example, solid materials. Thus solid materials are widely used in turbocharger parts. A material called high-Cr cast iron is especially popular when high heat resistance and high wear resistance are required.

However, sintered materials can reduce costs by using the near net shape technique. Thus the development of new materials with greater performance provides us with an opportunity to enter the growth market for turbocharger parts.

## 4 Content of Technology

Our developed material is based on the idea of including a large amount of Cr in order to form passivation of oxidized layer. Our target is that the properties of developed material exceed conventional high-Cr cast iron in the turbocharger market. The key technologies are as follows:

### (1) High densification with liquid-phase sintering

Pores in sintered materials have many disadvantages under a high-temperature environment. Internal oxidation causes great reduction in strength and dimensional swelling. In general, sintered materials are sintered in the solid-phase temperature region. However, the material we developed is sintered in the liquid phase. By applying this liquid-phase sintering, we achieve high densification and prevent the progress of oxidation to the interior. In contrast to conventional sintered materials, which have a porosity of 10%, our developed material has a porosity of 3%.

### (2) Improving wear resistance and securing oxidation resistance with dispersion of fine particle shape carbides

The wear resistance of our developed material has increased by dispersing carbides in the same way as high-Cr cast iron. However, because the carbides used in our developed material is in the shape of fine particles, the Cr-poor layer formed around the carbides is discontinuous. This makes it difficult for oxidation, which is believed to progress preferentially from the Cr-poor layer, to proceed. This is also considered to be a major reason why the material’s performance exceeds high-Cr cast iron with dispersed network carbides.

**Figure 1** shows a comparison of wear resistance. **Figure 2** shows a comparison of resistance to oxidation. They show that both properties of our developed material are superior to high-Cr cast iron. **Figure 3** shows the metallic microstructure of our developed material.

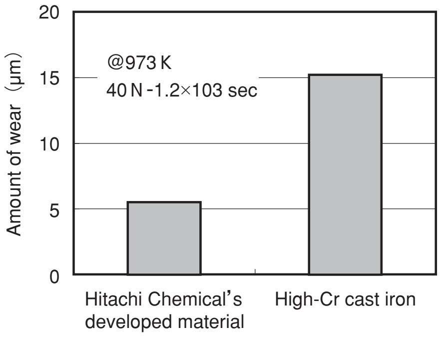

Figure 1 Results of wear test

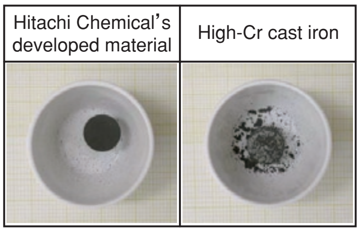

Figure 2 Appearance after oxidation test (1273 K, $3.6 \times 10^5$ sec, in open air)

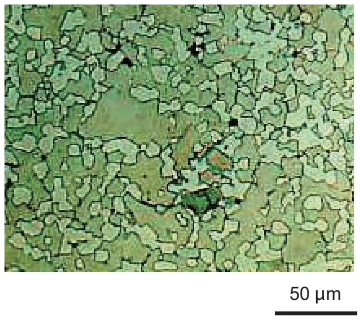

Figure 3 Microstructure

The material we developed is already being used in the market. Our efforts to further expand the market are as follows:

- Pursue high wear resistance (optimize dispersion and shape of carbides).
- Pursue oxidation resistance (optimize composition of base material).
- Improve rigidity under high temperature.

**【References】**

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**【Filed Patent】**

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