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Low friction of ta-CNx coating under refrigerant environment

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Friction tests were conducted in a refrigerant environment using ta-CNx deposited by IBA-FAD method. As a result, the coefficient of friction in dry friction in the atmosphere of the R 32 refrigerant was about 0.02. The low friction coefficient of 0.03 or less was confirmed in the refrigerant and refrigerating machine oil environment. The effect of tribo-film on the friction coefficient was clarified by observation of the sliding surface after the friction test and reflection spectroscopy analysis, and the low friction mechanism of ta-CNx coating under the refrigerant environment was proposed.

Keywords : ta-CNx, low friction, IBA-FAD, Refrigerant

1. Introduction

Energy saving in refrigeration and air conditioning equipment is required, and reduction of friction loss in sliding parts is one of the means of energy saving. In recent years, low friction has been reported with carbon-based hard coatings, and ta-CNx coatings have been reported to have a friction coefficient of 0.01 or less under dry nitrogen atmosphere [1] [2]. However, there is no report in the refrigerant environment. Therefore, the friction properties of ta-CNx coating were evaluated.

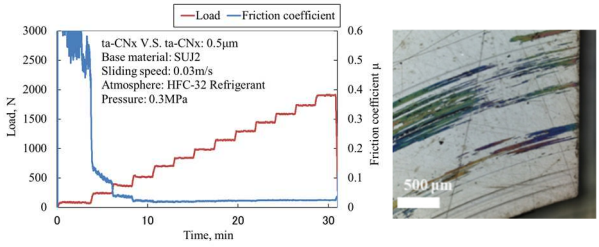
2. Experimental

The ta-CNx coating was deposited using an IBA-FAD device and a gridless ion beam generator. A ring-on-disk friction tester was used for the friction test. The friction test was carried out in the drying friction of the refrigerant gas and in the refrigerant and refrigerator oil environment. The load increased at regular intervals. After the friction test, the sliding surface was analyzed using reflection spectroscopy.

3. Results and discussions

Fig.1 shows the dry friction test results in the R32 refrigerant atmosphere. Although the coefficient of friction was high immediately after the start, it soon fell below 0.03. And, the low friction was maintained, even if the load was increased. Figure 2 shows the results of friction tests in a refrigerant and refrigerating machine oil environment. Although the coefficient of friction without coating was 0.1 or more, the coefficient of friction of ta-CNx coating was 0.03 or less.

As a result of observing the sliding surface after the dry friction test in the atmosphere of R 32 refrigerant, tribo-film was confirmed on the sliding surface. As a result of reflection spectroscopic analysis of the sliding surface, the refractive index n of tribo-film was 2 or less, the extinction coefficient k was 0.15, and the value of polymer-like carbon was shown in the classification reported by Hiratsuka et al. [3]. From the results of reflection spectroscopic analysis, it is considered that soft tribo-film was formed on the sliding surface, and low friction appeared by low shear thin film solid lubrication.



(a) Dry friction test (b) Surface condition after friction test

Figure 1: Dry friction in R32 refrigerant atmosphere

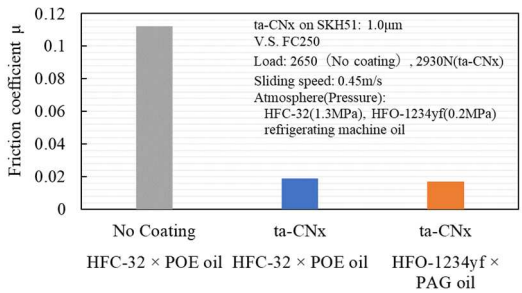


Figure 2: Average friction coefficient of refrigerant and refrigerating machine oil environment

4. Conclusions

The low friction properties of ta-CNx coating in a refrigerant environment were confirmed, and the influence of tribo-film on the friction coefficient was clarified using reflection spectroscopy.

5. References

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