

# M-Coat, New Dry Film Lubricant for Hot-Rolled Steel Sheet\*

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## 1 Introduction

Hot-rolled steel sheets with dry film lubricant, which possesses excellent formability, have been produced at Kawasaki Steel commercially. The steel sheets are suitable for applications of wheels and frames of automobiles. Recently there have been strong demands to use high strength steel for weight reduction of vehicle body and strong tendency to adopt hot-rolled steel instead of cold-rolled steels for purpose of reduction of cost. However, these changes in materials may cause deterioration of press formability,<sup>1)</sup> therefore, new type steel sheets having superior friction property of dry film are more strongly requested for than that of the conventional one. The hot-rolled steel sheets with a new dry lubricant "M-coat", which have an excellent deep drawing and pure-stretching formability, have been developed via the new organic thin film with an excellent friction property. This report describes the features and quality of "M-Coat"

## 2 Features of "M-Coat"

### 2.1 Product Composition

Figure 1 shows a schematic diagram of the dry film lubricant-coated steel sheet. It has a two-layered struc-

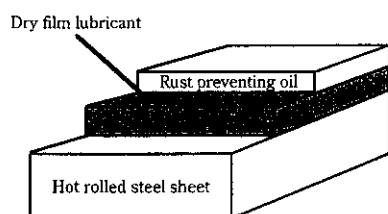


Fig. 1 Schematic illustration of dry film lubricant coated steel sheet

ture consisting 1~2  $\mu\text{m}$  thick organic film containing a lubricant, an anti-rust agent under the rust preventing oil.

### 2.2 Friction Properties

"M-Coat" has excellent friction properties as a result of using the friction agent and optimizing tensile strength of dry film, compared to conventional one. Figure 2 shows the flat die friction test method and relationship between friction coefficient and holding pressure of hot-rolled steels with various lubricant films. Friction coefficient of "M-Coat" was reduced by more than 30% compared to that of conventional hot rolled steels with rust-preventing oil.

### 2.3 Press Formability

Figure 3 shows a conic trapezoid shape forming test and blank holding force range of possible press forming. The blank holding force range of "M-Coat" is more than 2.5 times wider than that of rust-preventive lubricating oil and more than 1.5 times wider than that of press oil.

The newly developed dry film lubricant is also applied to high strength steel for the purpose of improving press formability. "M-Coat" high strength steel shows the similar blank holding force range as a hot-rolled mild steel with press oil. The enhancement of press formability of the new dry film lubricant steel sheet is attributed to an increase in material inflow into the die and expansion of the strain distribution at contact parts to die owing to the improvement of friction property.

### 2.4 Degreasability

Phosphate layer plays an important role to obtain strong adhesion to post paint layer. Therefore, dry film lubricant must be removed completely during the alkaline degreasing process, prior to phosphate treatment. Table 1 shows the rate of organic components for dissolution during an alkaline spray degreasing solution test

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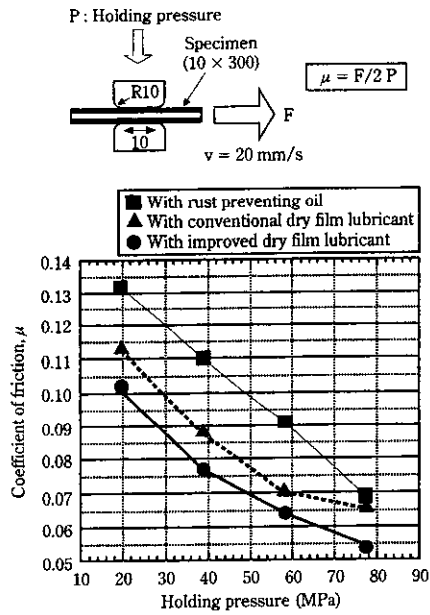


Fig. 2 Relationship between coefficient of friction and holding pressure

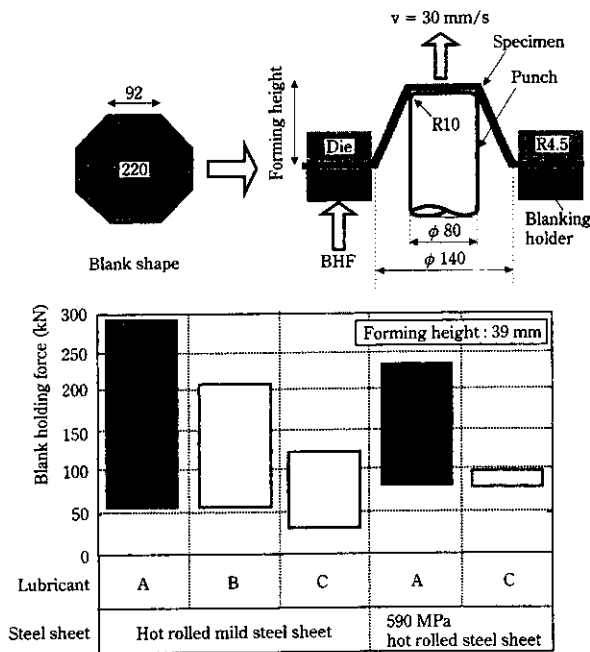


Fig. 3 Effect of dry film lubricant on press formability (range of blank holding force); A: Dry film lubricant, B: Press oil, C: Rust preventive lubricating oil

at various treatment time (10~90 s). The new dry film shows the same results as rust-preventing oil degreasing property on a hot-rolled steel sheet.

### 2.5 Primary Corrosion Resistance

It is well recognized that hydrophilic resin in the

Table 1 Degreasability of dry film lubricant

Degrease time (s)	Rate of organic component dissolution*1	
	Dry film lubricant	Rust preventing oil
90	1.00	1.00
60	1.00	1.00
10	1.00	1.00

\*1Rate of organic component dissolution  

$$= \frac{(\text{Carbon count before alkaline degrease}) - (\text{Carbon count after alkaline degrease})}{(\text{Carbon count before alkaline degrease}) - (\text{Carbon count of steel sheet})}$$
 (Fluorescent X-ray)

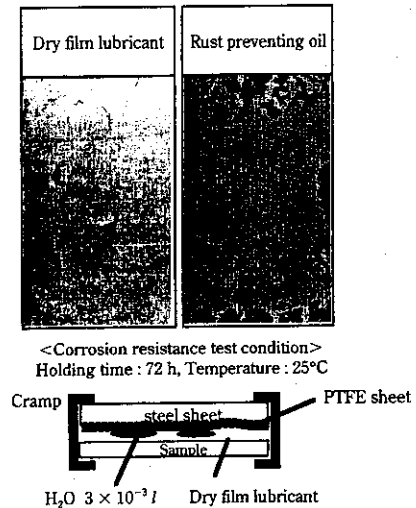


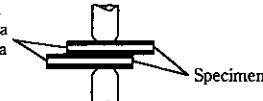
Fig. 4 Corrosion resistance of the steel sheet with dry film lubricant

lubricant film improves an alkaline degreasing property, however, primary corrosion resistance of lubricated steel deteriorates with increasing in hydrophilic property of film. By using special resin, newly developed dry film lubricated steel accomplished an excellent primary corrosion resistance with maintaining a good alkaline degreasing property. Newly developed dry film lubricated steel "M Coat" shows the better primary corrosion resistance than steel with rust-preventing oil, as shown in Fig. 4.

### 2.6 Spot Weldability

The steel sheets with dry film lubricant itself are assembled into automobiles by spot welding. Therefore, it is inevitably important to maintain sufficient range of proper welding current. As shown in Fig. 5, the proper spot welding current range of dry film lubricated steel is shifted toward a lower current compared with that of rust-preventing oil steel sheet. However, the current range width is almost the same as that for steel with rust-preventing oil.

SPHD 1.2 mm  
 YP: 254 MPa  
 TS: 368 MPa  
 El: 44.5%



Specimen

Lubricant	Proper welding current range (kA)					
	5	6	7	8	9	10
Dry film lubricant						
Rust preventive oil						

Welding conditions  
 Electrode force : 2.9 kN  
 Electrode shape : CF type  $\phi 5$   
 Primary holding time : 50 cycles  
 Welding time : 8 cycles  
 Holding time : 30 cycles  
 Nugget diameter :  $\approx 5.48$  mm ( $5\sqrt{t}$ )

Fig. 5 Spot weldability of steel sheet with dry film lubricant

### 3 Concluding Remarks

“M-Coat” brought a remarkable improvement of excellent press formability resulting from the newly developed dry film lubricant treatment, without lowering primary corrosion resistance, spot weldability and alkaline degreasability as compared with rust-preventing oil. The newly developed “M-Coat” is suitable for press forming of hard-to-form materials or panels, e.g., high tensile strength steel sheets. Application of the new dry film lubricating treatment is expected to expand to other types of steel sheets.

### Reference

- 1) H. Hayashi: *Jidosha-Gijyutsu*, 49(1995)5, 11

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