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(71) Applicant: **National Cheng Kung University**
Tainan City 701401 (TW)

(72) Inventor: **JENG, YEAU-REN**
701401 Tainan City (TW)

(74) Representative: **Straus, Alexander**
2K Patent- und Rechtsanwälte - München
Keltenring 9
82041 Oberhaching (DE)

(54) A LUBRICANT USING VEGETABLE OIL AND HAVING A SELF-GENERATING FRICTION FILM

(57) A lubricant made from vegetable oil that can form a friction film when used. The lubricant has 86-99 wt% of vegetable oil that contains double bonds and bis-allylic protons, 10-0.5 wt% synthetic FAT, 3.6-0.3 wt% surface active agent, and 0.4-0.2 wt% antioxidant. Additionally, the weight percentages of surface active agent are 3.6~0.3wt%, and the weight percentages of antioxidant are 0.4~0.2wt%.

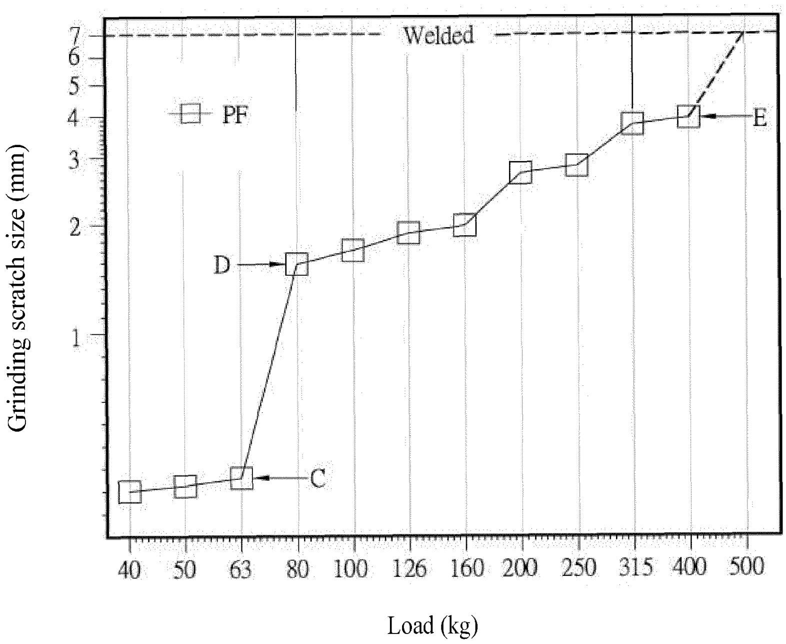

Fig. 1

Processed by Luminess, 75001 PARIS (FR)

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Description

FIELD OF THE DISCLOSURE

[0001] The present disclosure relates in general to a lubricant, and more particularly, to the lubricant made from vegetable oil that can self-generate a friction film during usage.

BACKGROUND OF THE DISCLOSURE

[0002] Lubricants are very important substances because they can reduce energy costs and energy consumption, as well as prevent wear or damage to parts, thus prolonging the service life of mechanical parts.

[0003] The lubricants commonly used in the industry are usually made of either mineral oil or synthetic oil, which is derived from petroleum derivatives and can be harmful to the environment when they are discarded after each use. Therefore, mineral or synthetic oil-based lubricants are considered as having environmentally unfriendly substances.

[0004] Currently known types of vegetable oil, such as palm oil as derived from plants, is a triglyceride (TAG) that has a polar head group (polar head group) that is not present in mineral oil, and therefore allowing vegetable oil to better interact with metal surfaces. However, because of the high molecular weight and low volatility and high flash point, vegetable oil is chemically unstable. In addition, vegetable oil contains double bonds and bis-allylic protons, which are easily attacked by free radicals, resulting in undesirable side effects. Therefore, vegetable oil alone is not an ideal lubricant.

[0005] Recently, there has been an increasing interest in self-generated tribofilms, especially amorphous carbon (a-C) friction films, which can be formed from friction of contact interfaces during, e.g., sliding therebetween.

[0006] As such, it would be desirable for the vegetable oil to be added with additives to yield a complex vegetable oil and formulate a novel lubricant that can produce an amorphous carbon friction film during use. Such novel lubricant will not only make the lubrication effect better and reduce wear, but will also be friendlier to the environment, and therefore significantly change the market ecology of the conventional mineral oil-based lubricant.

SUMMARY OF THE DISCLOSURE

[0007] It is therefore an object of the present disclosure to construct an oil-based lubricant using vegetable oil as the base.

[0008] A further object of the present disclosure is to have the vegetable oil based lubricant self-generate a friction film during usage.

[0009] In order to achieve the above-mentioned objects, the present disclosure uses the vegetable oil as the base for the lubricant that can form a friction film when used. Specifically, the lubricant includes 86~99wt% vegetable oil containing double bonds and bis-allylic protons, 10~0.5wt% synthetic fat, 3.6~0.3wt% surface active agent, and 0.4~0.2wt% antioxidant. Synthetic FAT, 3.6~0.3wt% surface active agent, and 0.4~0.2wt% antioxidant.

[0010] With the above-mentioned features, the present disclosure is friendlier to the environment when it is disposed of after use. In addition, the lubricating oil of the present disclosure can form an amorphous carbon friction film during the process of use under pressure, which can greatly improve the lubricating effect and further reduce the wear and tear.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] In order to illustrate the technical features of the present disclosure in detail, an exemplary embodiment is illustrated with drawings, wherein:

Fig. 1 is a schematic diagram showing test results of a first lubricant having palm oil as the type of vegetable oil according to a first exemplary embodiment of the present disclosure;

Fig. 2 is a schematic diagram showing test results of a second lubricant having mineral oil instead of vegetable oil according to the first exemplary embodiment of the present disclosure;

Fig. 3 is a comparative schematic diagram comparing the test results of the vegetable (palm) oil-based first lubricant and mineral oil-based second lubricant of the first exemplary embodiment of the present disclosure;

Fig. 4 is a Raman shift diagram of the first exemplary embodiment of the present disclosure;

Fig. 5 is a schematic diagram showing test results of a third lubricant having palm oil as the type of vegetable oil according to a second exemplary embodiment of the present disclosure;

Fig. 6 is a schematic diagram showing test results of a fourth lubricant having mineral oil instead of vegetable oil according to the second preferred embodiment of the present disclosure; and

Fig. 7 is a comparative schematic diagram comparing the test results of the vegetable (palm) oil-based third lubricant and mineral oil-based fourth lubricant of the second exemplary embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0012] In order to illustrate the technical features of the present disclosure in detail, the following exemplary embodiments are cited and illustrated with accompanying drawings, among others.

[0013] As shown in Figs. 1 to 4, a first exemplary embodiment of the present disclosure is a first lubricant which uses vegetable oil as the base, and particularly palm oil as the type of vegetable oil ("first palm oil-based lubricant PF") that can self-form a friction film when in use. The first palm oil-based lubricant PF is composed of 86 wt% vegetable oil with double bonds and bis-allylic protons, 10 wt% synthetic FAT, 3.6 wt% surfactant, and 0.4 wt% antioxidant.

[0014] The aforementioned surface active agent has Fatty Alcohol Epoxide Group with 1.5 wt%, Polyethylene Glycol Oleate with 1.1 wt%, Polyethylene Glycol Cetyl/Oleyl Ether with 0.3 wt%, and Sodium Stearate with 0.7 wt%. Polyethylene Glycol Cetyl/Oleyl Ether at 0.3 wt% and Sodium Gualenate at 0.7 wt%. The four surface-active agents listed here are examples, and in practice, one or more of the four surface-active agents can be used in a mixture.

[0015] The aforementioned antioxidant in this embodiment is Octylated Diphenylamine. In order to adjust the viscosity, the percentage of the antioxidant can be reduced to 0.2% by weight and a 0.2% viscosity modifier, such as polybutylene, can be added.

[0016] A four-ball lubrication tester (under the code of ASTM 2783) (not shown in the figure) is used to test the first palm oil-based lubricant PF. The ball tester is a standard test device for evaluating the performance of oil-based products. The test results of the first palm oil-based lubricant PF are shown in Fig. 1. The part below point C as shown in Fig. 2 indicates good lubrication effect; between point C and point D is the transition area before the load constitutes a scratch; between point D and point E, the scratch size increases steadily with the increase of the load; and after point E, the failure of the lubricating oil PF makes the scratch size increase significantly, which causes the fusion between the upper ball and the lower ball. As such, point E in Fig. 1 is the effective limit of the first palm oil-based lubricant PF.

[0017] In Fig. 2, the result of the test conducted by the four-ball lubrication test machine after replacing the aforementioned 86 wt% palm oil with 86 wt% mineral oil to become a mineral oil-based lubricating oil ("mineral oil-based lubricant MF"). Fig. 3 shows the combined results of the ones as shown in Figs. 1 and 2. As illustrated in Fig. 3, the first palm oil-based lubricant PF has a higher load bearing capacity than the mineral oil-based lubricant MF.

[0018] If a Raman spectra test is performed on the aforementioned lower ball, the dark material in the scratch on the surface of the aforementioned lower ball will show its test results. However, before the actual test, the first palm oil-based lubricant PF can be added with Tricresyl Phosphate (TCP) in order to generate more spectra during the Raman spectroscopy test. However, since TCP is toxic to the environment, it is added only for the convenience of performing the Raman spectroscopy. In other words, it is not necessary to add TCP to the first palm oil-based lubricant PF when not performing the Raman spectra test. The content of the Raman spectroscopy is shown in Fig. 4, which has a dark material in the scratch with a distinct G-band and D-band, indicating the presence of hydrogenated amorphous carbon, especially a graphite peak at 1580 cm-1 at 63 kg load and at 2900 cm-1. The testing process reveals that the first palm oil-based lubricant PF of the present disclosure can form an amorphous carbon friction film.

[0019] This first embodiment illustrates that the first palm oil-based lubricant PF of the present disclosure is friendlier to the environment, and, in the process of use and when subjected to pressure (i.e., when subjected to the pressure of objects rubbing against each other), it can form an amorphous carbon friction film, which greatly improves the lubrication effect and further reduces the wear of objects.

[0020] In addition, although palm oil is used in the first exemplary embodiment as the source of the vegetable oil, other types of vegetable oil can be used, particularly the ones containing double bonds and bis-allylic protons, which can replace palm oil and have similar effects as the first palm oil-based lubricant PF.

[0021] As shown in Figs. 5 to 7, a second lubricant which uses vegetable oil as the base, and particularly palm oil as the type of vegetable oil ("second palm oil-based lubricant PF'") that can self-form a friction film when in use is disclosed as a second preferred embodiment of the present disclosure. The second palm oil-based lubricant PF' is composed of 99 wt% vegetable oil containing double bonds and bis-allylic protons, 0.5 wt% synthetic FAT, 0.4 wt% surface active agent, and 0.1 wt% antioxidant. wt% of antioxidant.

[0022] The aforementioned surface active agent comprises Fatty Alcohol Epoxide Group with 0.1 wt%, Polyethylene Glycol Oleate with 0.1 wt%, Polyethylene Glycol Cetyl/Oleyl Ether with 0.1 wt%, and Sodium Stearate with 0.1 wt%. Polyethylene Glycol Cetyl/Oleyl Ether) at 0.1 wt% and Sodium Gualenate at 0.1 wt%.

[0023] A four-ball lubrication tester (not shown in the figure) is used to test the second palm oil-based lubricant PF', and the test results are shown in Fig 5. Fig. 7 is a schematic diagram showing the combined results of the ones as shown in Figs. 5 and 6. As shown in Fig. 7, the second palm oil-based lubricant PF' in the second embodiment has a slightly higher point D than the mineral oil M', and a slightly left point E than the mineral oil M'. In other words, the lubrication limit load is slightly worse than the mineral oil M' and the size of the scratch produced is larger; the lubrication limit load is slightly worse than that of mineral oil M'; and the size of the scratches produced is larger. Nonetheless, one or more needs of a user can be met when the user does not have a high demand for lubrication, and the formation of an amorphous carbon friction film can still be accomplished.

[0024] Even when the weight percentage of palm oil in the second embodiment is increased to 99wt%, a certain degree of lubricating effect is still present while being more friendly to the environment, and the self-generation of the amorphous carbon friction film can still be achieved during usage.

[0025] The present disclosure has been described with reference to the exemplary embodiments, and such description is not meant to be construed in a limiting sense. It should be understood that the scope of the present disclosure is not limited to the above-mentioned embodiment, but is limited by the accompanying claims. It is, therefore, contemplated that the appended claims will cover all modifications that fall within the true scope of the present disclosure. Without departing from the object and spirit of the present disclosure, various modifications to the embodiments are possible, but they remain within the scope of the present disclosure, will be apparent to persons skilled in the art.

Claims

1. A lubricant with vegetable oil as a base to generate a friction film during usage, comprising:
86~99wt% by weight of vegetable oil containing double bonds and bis-allylic protons, 10~0.5wt% by weight of synthetic FAT, 3.6~0.3wt% by weight of surface active agent, and 0.4~0.2wt% by weight of antioxidant. 0.4~0.2wt% of antioxidants.

2. The lubricant according to claim 1, wherein the weight percentage of the vegetable oil is 86 wt%, the weight percentage of the synthetic fat is 10 wt%, the weight percentage of the surface active agent is 3.6 wt%, and the weight percentage of the antioxidant is 0.4 wt%.

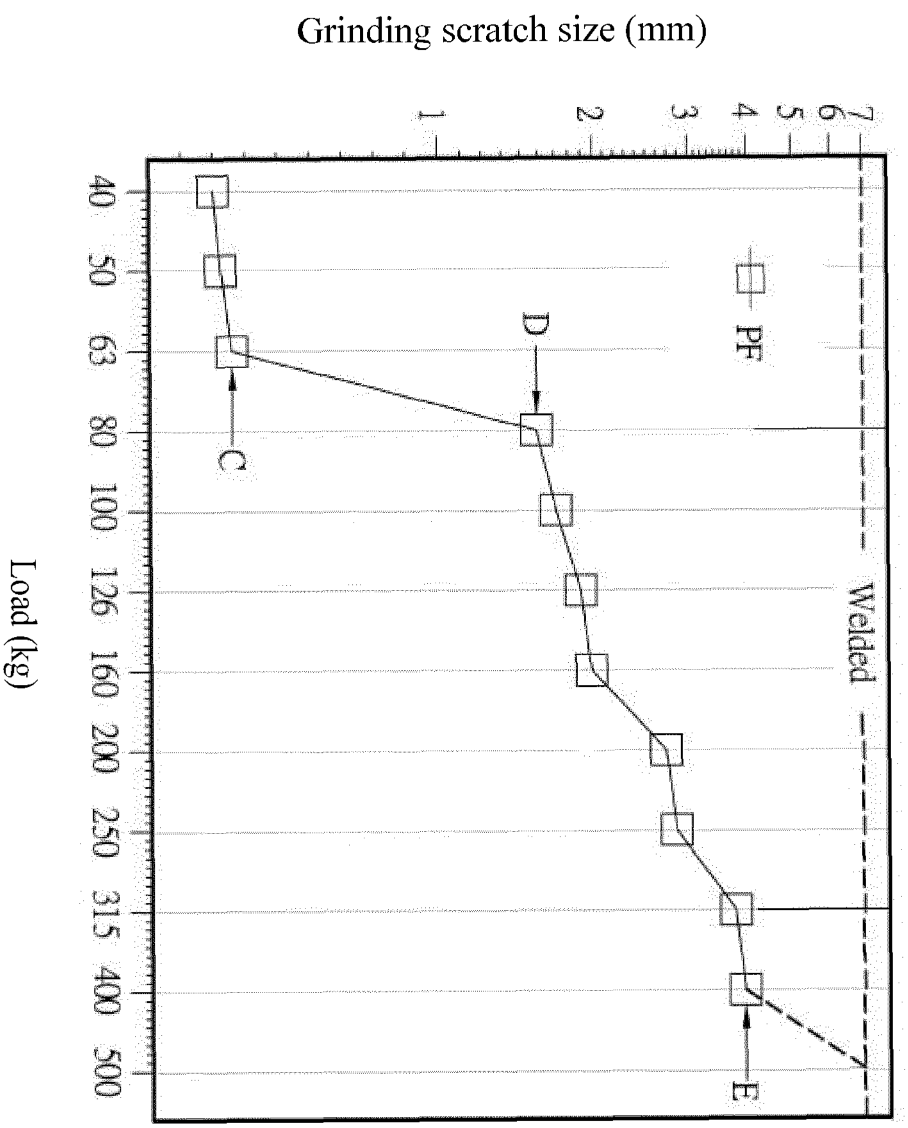
3. The lubricant according to claim 1, wherein the weight percentage of the vegetable oil is 99wt%, and the weight percentage of the synthetic fat is 0.5wt%, the weight percentage of the surfactant is 0.4wt%, and the weight percentage of the antioxidant is 0.1wt%.

4. The lubricant according to claim 1, wherein the surfactant is at least one of Fatty Alcohol Epoxide Group, Polyethylene Glycol Oleate, Polyethylene Glycol Cetyl/Oleyl Ether, and Sodium Gualenate, and wherein the surfactant is at least one of the following: Fatty Alcohol Epoxide Group, Polyethylene Glycol Oleate, Polyethylene Glycol Cetyl/Oleyl Ether, and Sodium Gualenate.

5. The lubricant according to claim 4, wherein the weight percentage of the surface active agent is 3.6 wt%, the weight percentage of the Fatty Alcohol Epoxide Group is 1.5 wt%, the weight percentage of the Polyethylene Glycol Oleate is 1.1 wt%, and the weight percentage of the Polyethylene Glycol Cetyl/Oleyl Ether is 0 wt%, and wherein the weight percentage of Polyethylene Glycol Oleate is 1.1wt%, the weight percentage of Polyethylene Glycol Cetyl/Oleyl Ether is 0.3wt%, and the weight percentage of Sodium Gualenate is 0.7wt%.

6. The lubricant according to claim 1, wherein the antioxidant contains Octylated Diphenylamine.

7. The lubricant according to claim 1, wherein palm oil is the type vegetable oil used.



Grinding scratch size (mm)
1
2
3
4
5
6
7
PF
D
C
E
Welded
40
50
63
80
100
126
160
200
250
315
400
500
Load (kg)

Fig. 1

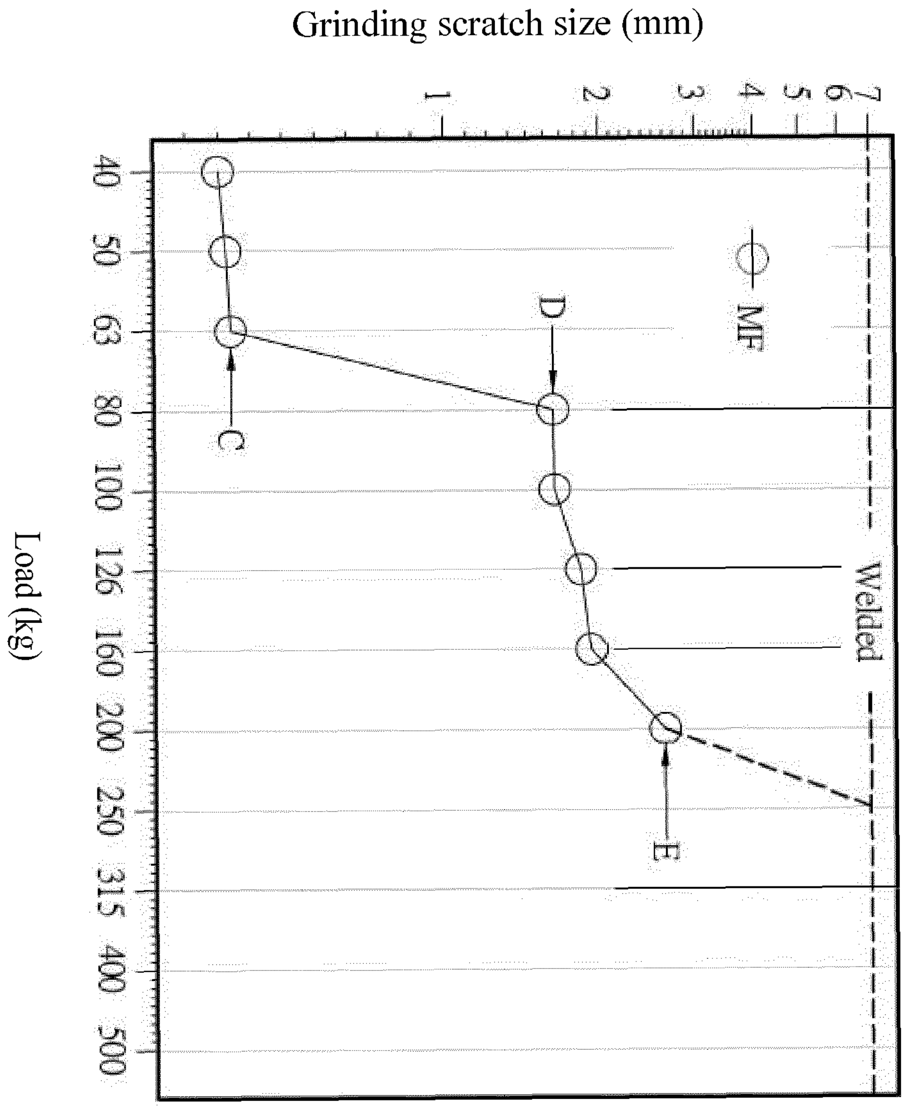

Grinding scratch size (mm)
1
2
3
4
5
6
7
MF
D
C
E
Welded
40
50
63
80
100
126
160
200
250
315
400
500
Load (kg)

Fig. 2

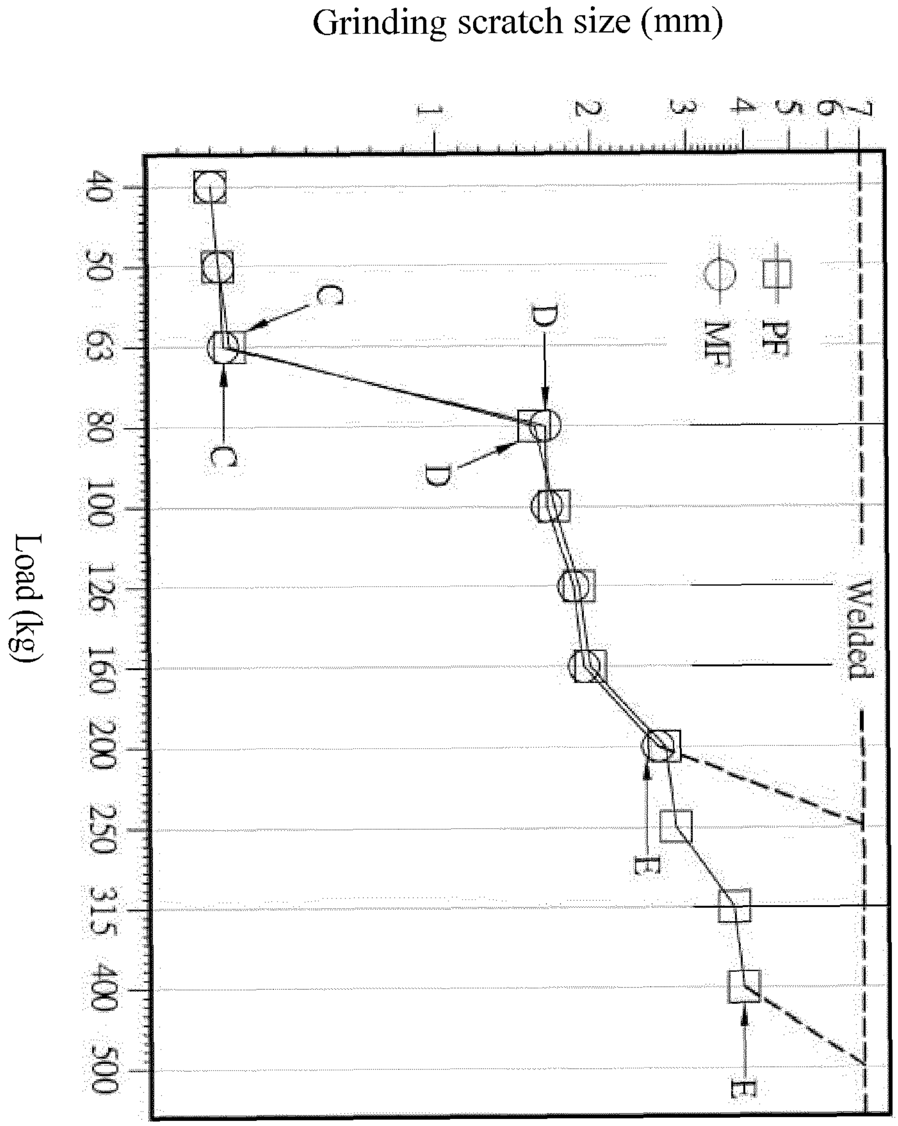

Grinding scratch size (mm)
1
2
3
4
5
6
7
Welded
PF
MF
C
C
D
D
E
E
40
50
63
80
100
126
160
200
250
315
400
500
Load (kg)

Fig. 3

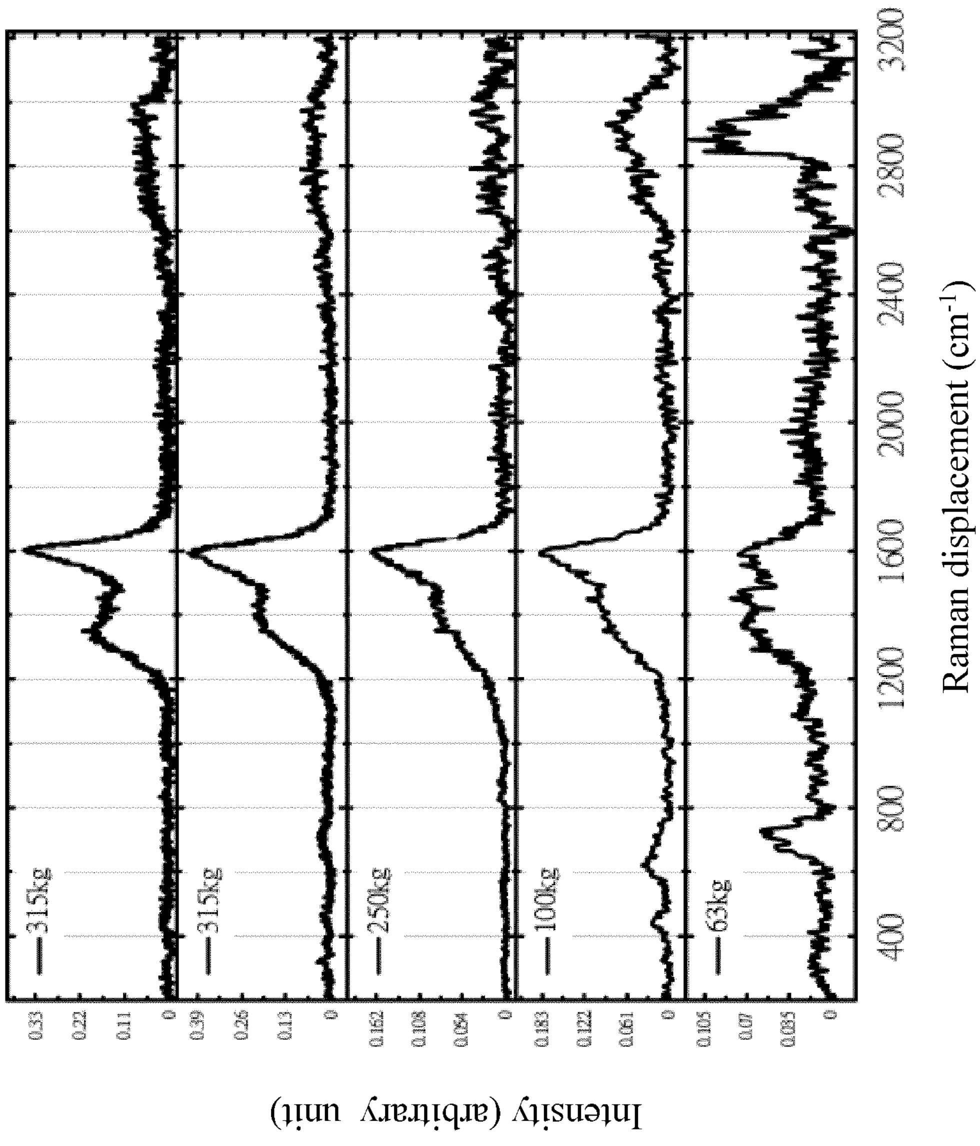

315kg
315kg
250kg
100kg
63kg
Intensity (arbitrary unit)
Raman displacement (cm-1)

Fig. 4

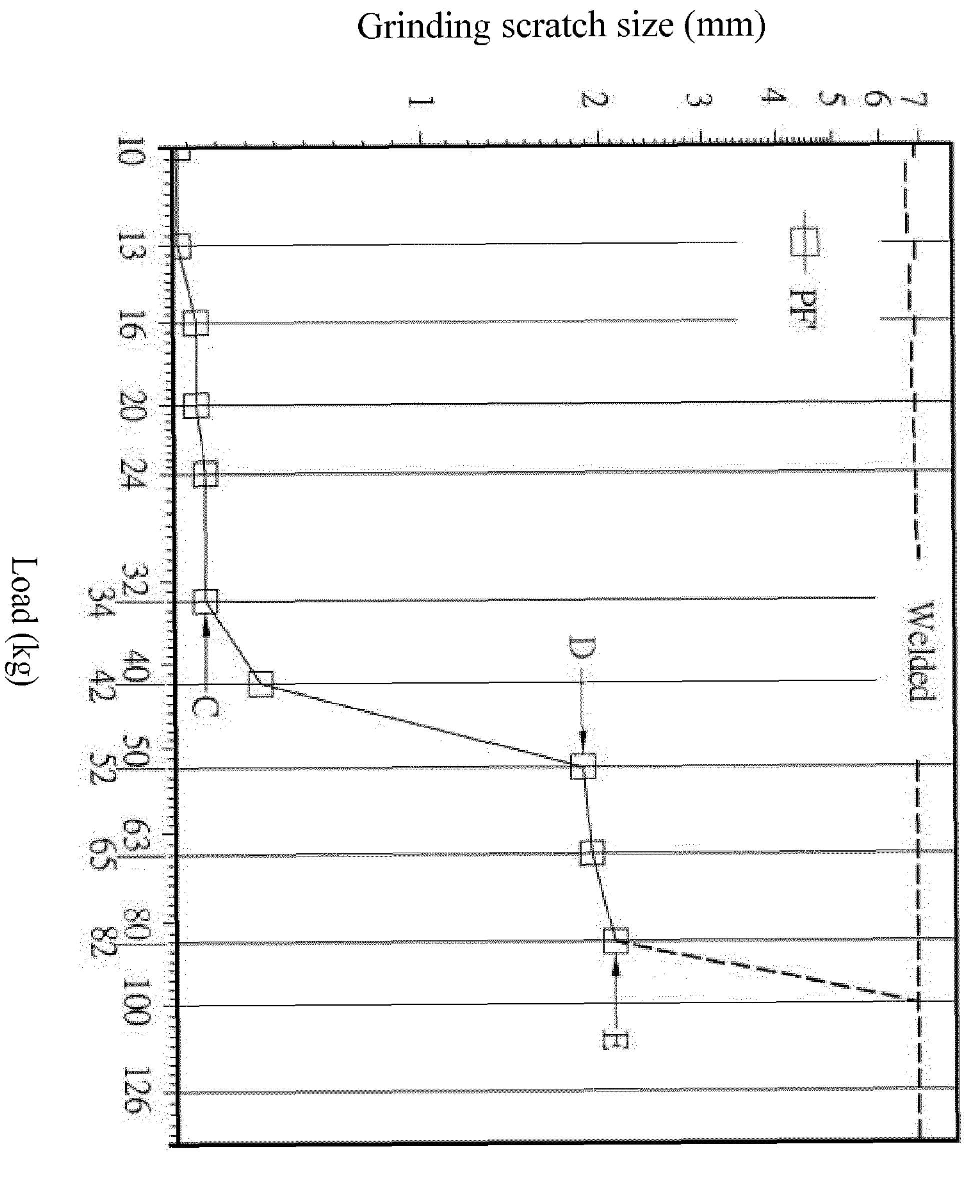

Grinding scratch size (mm)
1
2
3
4
5
6
7
PF
Welded
D
C
E
Load (kg)
10
13
16
20
24
32
34
40
42
50
52
63
65
80
82
100
126

Fig. 5

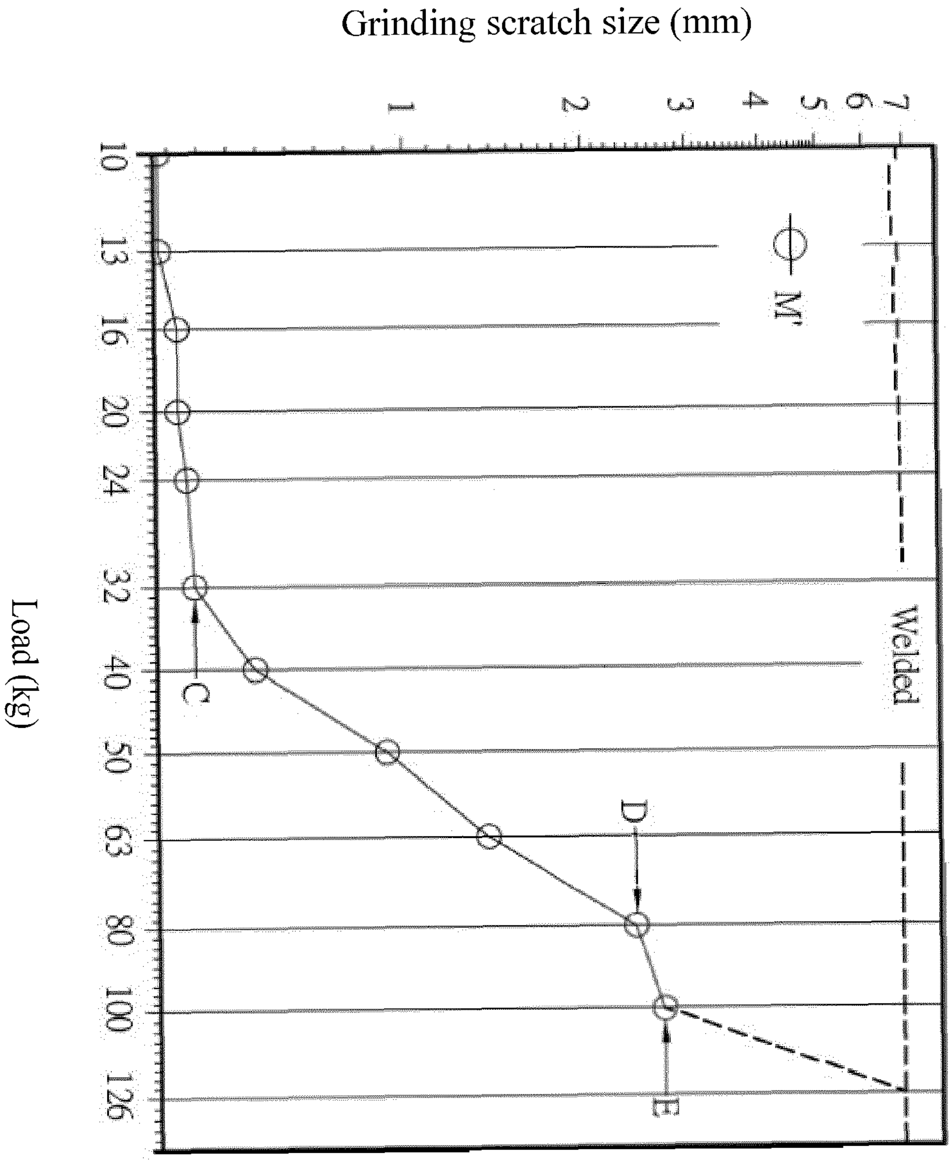

Grinding scratch size (mm)
1
2
3
4
5
6
7
M'
Welded
C
D
E
10
13
16
20
24
32
40
50
63
80
100
126
Load (kg)

Fig. 6

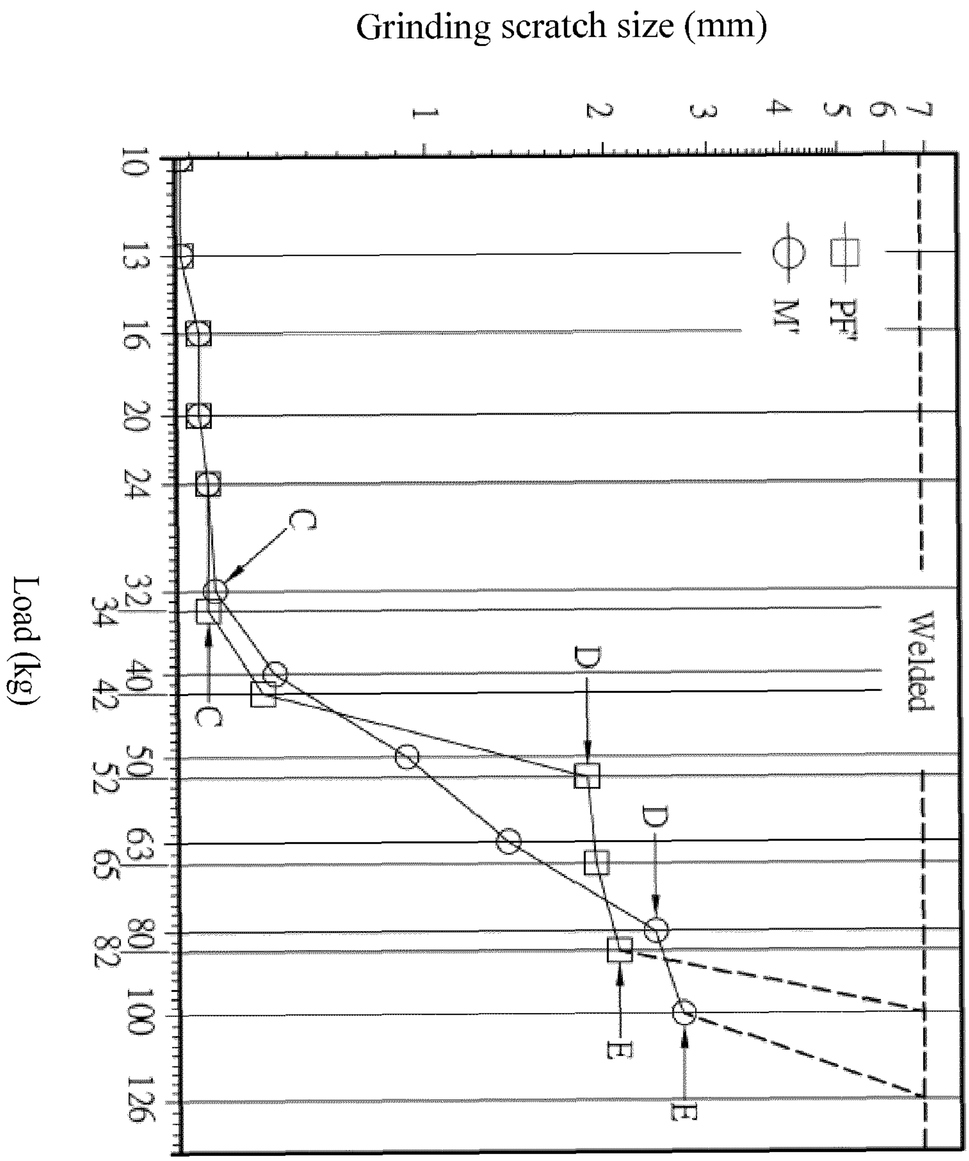

Grinding scratch size (mm)
1
2
3
4
5
6
7
PF'
M'
Welded
C
C
D
D
E
E
Load (kg)
10
13
16
20
24
32
34
40
42
50
52
63
65
80
82
100
126

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 22 20 1886

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 0 714 974 A1 (LUBRIZOL CORP [US]) 5 June 1996 (1996-06-05) * page 11, line 21 - line 55; claim 1; examples 2, 3; table 3 * -----	1-7	INV. C10M105/38 C10M169/04 ADD. C10N30/06 C10N20/00 C10N30/00
A	JP 5 391421 B2 (KYODO YUSHI) 15 January 2014 (2014-01-15) * claims 1, 3, 4 * -----	1-7	
A	US 4 783 274 A (JOKINEN KARI V J [FI] ET AL) 8 November 1988 (1988-11-08) * claim 2; example 5; table 10 * -----	1-7	
A	EP 1 702 972 A1 (NIPPON OIL CORP [JP]) 20 September 2006 (2006-09-20) * examples 4-6 * -----	1-7	
			TECHNICAL FIELDS SEARCHED (IPC)
			C10M C10N

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	26 May 2023	Kaluza, Nora

CATEGORY OF CITED DOCUMENTS

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Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 0714974	A1	05-06-1996	AU	685012	B2	08-01-1998
			BR	9504907	A	02-09-1997
			CA	2163843	A1	03-06-1996
			EP	0714974	A1	05-06-1996
			JP	H08209181	A	13-08-1996
			SG	38885	A1	17-04-1997
			US	5538654	A	23-07-1996
JP 5391421	B2	15-01-2014	JP	5391421	B2	15-01-2014
			JP	2010275352	A	09-12-2010
US 4783274	A	08-11-1988	CA	1225984	A	25-08-1987
			DE	3404243	A1	16-08-1984
			FR	2540884	A1	17-08-1984
			GB	2134923	A	22-08-1984
			PL	246163	A1	30-01-1985
			SE	445927	B	28-07-1986
			SU	1416059	A3	07-08-1988
			US	4783274	A	08-11-1988
EP 1702972	A1	20-09-2006	EP	1702972	A1	20-09-2006
			US	2007191240	A1	16-08-2007
			WO	2005063947	A1	14-07-2005

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