LUBRICATING COMPOSITION CONSISTING OF PARERYLATED SILANES AND SOLID LUBRICANT POWDERS

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8 Claims

ABSTRACT OF THE DISCLOSURE

High temperature lubricants comprising homogeneous mixtures of 10 to 90 percent by weight of parerylated silanes with 90 to 10 percent by weight of solid MoS₂, graphite, BN, aluminum powders, or low melting glass. The compositions disclosed herein have utility in meeting the elevated temperature lubrication requirements of the metalworking industry.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention relates to a composition of matter useful in the field of lubricants.

(2) Description of the prior art

In the field of lubricants it is impossible to predict whether any two or more components which might be combined to form a lubricant will be compatible and form a useful lubricating material. That is, even though each of two different chemical materials may be well known to have excellent characteristics as lubricants or as components of lubricants, one must still actually experiment in order to determine if the two different chemical materials may be used together as a mixture and if the mixture will prove to be even as good a lubricant as the separate entities by themselves are. The difficulty in predicting stems in part from the fact that any two or more chemical compounds, when placed together, may react chemically with each other or together with contacting surfaces. Moreover, even though the chemical components may be inert at room temperature they often react chemically at the elevated temperatures of operation to adversely affect their utility. On the other hand, one of the components may separate and sink to the bottom or rise to the top of a mixture and thus defeat the purpose of the mixture.

Even if two (or more) lubricating components are found to be chemically and physically compatible there are other factors to be considered before a mixture of the two (or more) can be considered useful as a lubricant. For example, in the field of metalworking there are many commercially available lubricants. Each of these lubricants has its own special limitation which makes it not quite as desirable a lubricant as it should be. Some good commercially available lubricants form undesired residue buildups on the metal being worked. Some have short pot life. Most decompose while in use and may give off noxious fumes and/or constitute a fire and explosion hazard. In others the lubricant doesn't adequately wet the metal being worked to provide the desired lubrication. These are representative of reasons why the previously available lubricants have been found wanting in some respect or other in the metalworking field.

Optimum lubrication with presently available lubrication materials prohibits the use of metalworking tool temperatures greater than about 500° F. even though current tooling can easily sustain operating temperatures of 800° F. Higher tooling temperature than the presently available 500° F. is considered to be an important factor in working with such materials as nickel-base super-alloys, which characteristically have a narrow working temperature range, and titanium alloys which have a strong tendency to seize. In particular, the demand for production of high quality titanium tubing, wherein seizing is a serious limiting factor, is increasing at a rapid rate. The most efficient means of manufacturing tubing is considered to be drawing, and the most desirable drawing temperature for alpha-beta titanium alloys is 800° F. The lack of a satisfactory lubricant at this temperature has required less efficient means of tube manufacture to be used in order to obtain the desired product.

SUMMARY OF THE INVENTION

The unexpected and a priori unpredictable properties of the new blended lubricants of this invention now make metal-working tooling operations at temperatures up to and including 800° F. possible. The lubricants disclosed herein all have fire points of greater than 800° F. and do not burn or decompose during use at temperatures up to 800° F. The lubricants of this invention, since they do not decompose at temperatures up to 800° F., may be used under continued service condition, which is not the case with the best of the prior art materials.

The blended lubricating materials of this invention consist of mixtures of parerylated silanes and such solid lubricants as molybdenum disulfide, graphite, boron nitride, aluminum powder, or low melting glass powder. Specific composition ranges and methods for forming the blends are described in detail in the following description of the preferred embodiments.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The lubricants of this invention may be prepared by a number of different methods.

(1) A parerylated silane and a solid lubricant powder may be ground together.

(2) A parerylated silane may be melted to a liquid and solid lubricant powder stirred in.

(3) Molten parerylated silane may be added to and stirred into solid lubricant powder.

(4) Parerylated silane may be dissolved in a solvent which is more volatile than the silane. Then solid lubricant powder may be added to the solution and the solvent evaporated.

Specific examples of parerylated silanes which may be used in practicing this invention are: phenyl-tris-(4-biphenylyl) silane, hexaphenylidilsilane, tetrakis-(4-biphenyl) silane, tetra-2-thienylsilane, phenyl-2-thienylsilane, and 3-pyridylthiophenylsilane. Specific examples of solid lubricants are molybdenum disulfide powder, graphite powder, boron nitride powder, low melting glass powder, and aluminum powder. The two classes of components (silane and solid powder) form compatible, useful lubricants when blended into compositions having weight ratios of solid to silane ranging from 50:10 to 90:10, inclusive. The weight ratio of solid to silane may be selected for the performance characteristics desired.

The term parerylated silanes, as used in this specification, may be defined as that class of molecules constructed from silicon atoms and aromatic or substituted aromatic moieties. The aromatic moieties may be selected from carbocyclic or heterocyclic groups either alone or mixed. Specific examples are, of course, given above.

The following are specific examples of lubricant preparations carried out.
EXAMPLE I
Powdered graphite was blended with phenyl-tris-(4-biphenylyl)silane. For this purpose, a measured amount of the silane was heated in a container to a temperature in the range from 320° F. to 500° F. Phenyl-tris-(4-biphenylyl)silane melts at about 320° F. and is a low viscosity liquid. The temperature of the molten silane was maintained and a measured amount of powdered graphite, 150-325 mesh, stirred in. Complete blending resulted with ease. The consistency of mixtures prepared in this manner varied from stiff putty-like to thick soup-like depending on the ratio of graphite to silane. The mixtures solidified to glass-like texture upon cooling. They softened to their original consistencies when reheated. Graphite did not tend to settle out except when high weight percentages of silane were mixed with coarser graphite powder. The mixtures could be cooled and heated many times without apparent change in characteristics. Compositions prepared in this way were 40 weight percent phenyl-tris-(4-biphenylyl)silane to 60 weight percent graphite, 50 weight percent of the silane to 50 weight percent graphite, and 60 weight percent of the silane to 40 weight percent of the graphite.

EXAMPLE II
Technical fine molybdenum disulfide powder was mixed with phenyl-tris-(4-biphenylyl)silane. The mixing procedure of Example I was used. Consistencies and characteristics of the silane-MoS2 mixtures were similar to those of the silane-graphite mixtures of Example I except MoS2 did not tend to settle out even when high weight percentages of silane were used. Lubricants consisting of the following percentages by weight were prepared: (1) 30% of the silane to 70% MoS2, (2) 50% of the silane to 50% MoS2, and (3) 90% of the silane to 10% MoS2.

EXAMPLE III
Technical fine molybdenum disulfide powder was added to tetrakis-(4-biphenylyl)silane. To prepare such compositions, the silane was placed in a container and the container heated to a temperature in the range from about 500° F. to about 700° F. Tetrakis-(4-biphenylyl)silane melts at about 540° F. and, like the silane of Examples I and II, is, when melted, a low viscosity liquid. After the silane was melted, powdered MoS2 was added to and stirred into the silane. A 50-50 by weight mixture was prepared. Upon cooling, the composition solidified to a crystalline form rather than to the amorphous (glass-like) form of the mixtures of Examples I and II. However, upon re-heating and recooling, the material solidified into an amorphous form. The mixture exhibited no visible change in consistency at working temperatures.

EXAMPLE IV
Phenyl-tris-(4-biphenyl) silane was mixed with boron nitride and with aluminum powder in the same manner disclosed by Example I. Materials and compositions were (weight percentages): (1) 67% of the silane to 33% boron nitride powder and (2) 67% silane to 33% aluminum powder. The mixing with BN required crushing to eliminate lumps in the boron nitride.

EXAMPLE V
Blends of various perarylated silane-solid lubricant mixtures were prepared. The blends were prepared by heating one mixture in a container until a smooth consistency resulted, adding a second mixture, and stirring. Blends prepared were (weight percentages): (1) 50% of 50% phenyl-tris-(4-biphenyl) silane 50% molybdenum disulfide, (2) a 50/50 mixture of 50% tetrakis-(4-biphenylyl)silane-50% molybdenum disulfide with 50% phenyl-tris-(4-biphenyl)silane-50% molybdenum disulfide, (3) a 50/50 blend of 50% phenyl-tris-(4-biphenyl) silane-50% MoS2 and 67% phenyl-tris-(4-biphenyl) silane-33% BN, and (4) a 50/50 blend of 50% phenyl-tris-(4-biphenyl) silane-50% MoS2 with 67% phenyl-tris-(4-biphenylyl)silane-33% Al powder.

EXAMPLE VI
Other preparation methods were used. Mixtures of perarylated silanes such as hexaphenylsilaslane, tetra-2-thiophenylsilane, phenyl-2-thiophenylsilane, and 3-pyridyl-3-phenylsilane were blended with MoS2 graphite, aluminum powder, powdered low melting glass, or boron nitride by grinding in a mortar (or by grinding in another suitable manner such as in a ball mill) and then heated to temperatures on the order of about 500° F. All such combinations were almost immediately fused by the melting action of the perarylated silane and appeared to have the same characteristics as mixtures prepared according to the methods of Examples I through V above.

EXAMPLE VII
Equal mixtures by weight of powdered MoS2 and hexaphenylsilaslane were heated on a hot plate and stirred together. The mixture was then allowed to freeze. A portion of the frozen mixture was remelted and powdered phenyl-tris-(4-biphenyl) silane was added and stirred into the melt. Both portions of the mixture of MoS2 and hexaphenylsilaslane and the mixture of MoS2, hexaphenylsilaslane and phenyl-tris-(4-biphenyl) silane exhibited excellent lubricating properties for metalworking operations.

EXAMPLE VIII
Approximately equal weights of powdered graphite and phenyl-1-p-biphenylbis-(p-bromophenyl) silane were mixed by melting the silane, adding the graphite and stirring.

EXAMPLE IX
Approximately equal weights of powdered molybdenum disulfide and triphenyl-2-thiophenylsilane were blended in a test tube and heated.

Performance evaluation
The lubricating properties of compositions of this invention were evaluated during extrusion tests and compared with those of the best prior art lubricants. The 50-50 weight percent molybdenum disulfide-phenyl-tris-(4-biphenylyl)silane mixture gave the lowest values of container liner friction at 800° F. that have been obtained to date for extrusion operations under such conditions.

We claim:
1. A lubricating composition comprising a blend of (1) a perarylated silane having a structural formula selected from the group consisting of:
   Si(R1R2R3R4) and (R1R2R3)Si—Si(R1R2R4)
   wherein R1, R2, R3, R4, R5, and R6 are selected from the group consisting of carbamocyclic and dicyclic aromatic molecules, heterocyclic aromatic nitrogen or sulfur containing aromatic molecules, and mixtures thereof; and (2) a powder selected from the group consisting of molybdenum disulfide powder, graphite powder, boron nitride powder, glass powder, and aluminum powder, wherein from about 10 to about 90 weight percent of said blend is perarylated silane.

2. A lubricating composition comprising a blend of two components, the first component being selected from the group consisting of phenyl-tris-(4-biphenyl) silane, hexaphenylsilaslane, tetrakis-(4-biphenyl) silane, tetra-2-thiophenylsilane, phenyl-2-thiophenylsilane, and 3-pyridyl-3-phenylsilane; the second component being selected from the group consisting of the powders of molybdenum disulfide, graphite, boron nitride, low melting glass, and aluminum; wherein from about 10 to about 90 weight percent of said blend is said first component.
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3. A composition of matter according to claim 2 wherein said first component is phenyl-tris-(4-biphenyl) silane and said second component is powdered graphite.

4. A composition of matter according to claim 2 wherein said first component is phenyl-tris-(4-biphenyl) silane and said second component is powdered molybdenum disulfide.

5. A composition of matter according to claim 2 wherein said first component is tetrakis-(4-biphenyl) silane and said second component is powdered molybdenum disulfide.

6. A composition of matter according to claim 2 wherein said first component is phenyl-tris-(4-biphenyl) silane and said second component is boron nitride powder.

7. A composition of matter according to claim 2 wherein said first component is phenyl-tris-(4-biphenyl) silane and said second component is aluminum powder.

8. A lubricating composition comprising a blend of (1) at least two perarylated silanes selected from the group represented by the formulas:

\[
\text{Si}(R_1R_2R_3R_4) \quad \text{and} \quad (R_1R_2R_3)\text{Si}-\text{Si}(R_1R_2R_4)
\]

wherein \( R_1, R_2, R_3, R_4, R_5, \) and \( R_6 \) are selected from the group consisting of carboxymonocyclic and dicyclic aromatic moieties, heteroaromatic nitrogen or sulfur-containing aromatic moieties, and mixtures thereof; and (2) at least one powder selected from the group consisting of molybdenum disulfide, graphite, boron nitride, low melting glass, and aluminum, wherein from about 10 to about 90 weight percent of said blend is said perarylated silanes.

References Cited

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