and the back surface of the membrane within a battery. In this case, air permeability usually becomes worse due to densification of micropores, but it is desirable that the above described performance is exhibited while maintaining a certain range of air permeability. In addition, since foreign substances adhered to the surface of the membrane can also cause the occurrence of short-circuit, it is desirable that the membrane has a surface to which foreign substances are not easily adhered, that is, a surface having good slip characteristics, and has a dense micropore structure, in order to increase the breakdown voltage of the membrane.

[0003]

However, there are very few prior art documents regarding the surface slip characteristics and the micropore density of microporous membranes.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0004]

For example, Patent Document 1 discloses a polyolefin microporous membrane, whose dynamic friction coefficient is specified, use of the polyolefin microporous membrane as a separator capable of providing safety, good cycle characteristics and good winding properties of the microporous membrane at the same time.

[0005]

Further, Patent Document 2 discloses a method for producing a microporous membrane capable of achieving a low air permeability and a high breakdown voltage at the same time, using a material composition containing a polyolefin resin, a filler and a plasticizer.

Patent Document 1: JP 2010-202828 A

Patent Document 2: JP 2010-202829 A

SUMMARY

PROBLEMS TO BE SOLVED

[0006]

In Patent Document 1, the micropore structure of the polyolefin microporous membrane described therein has not been focused.

[0007]

The microporous membrane described in Patent Document 2 has a large membrane thickness, and is insufficient as a separator.

[0008]

Accordingly, an object of the present disclosure is to provide a polyolefin multilayer microporous membrane having a high permeability while having good slip characteristics between membranes and a dense microporous structure.

MEANS FOR SOLVING THE PROBLEMS

[0009]

To solve the problems described above, the polyolefin microporous membrane of the present disclosure has the following constitution:

That is, a polyolefin multilayer microporous membrane comprising: at least first microporous layers which form both surface layers and at least a second microporous layer disposed between the both surface layers, wherein the static friction coefficient of one of the surface layers of the polyolefin multilayer microporous membrane against the other surface layer in longitudinal direction (MD) is 1.1 or less, and wherein the pore density calculated from the average pore radius measured by mercury porosimetry method and the porosity, according to the formula below is 4 or more:

[0010]

Pore density = $(P/A^3) \times 10^4$

wherein A represents the average pore radius (nm) measured by mercury porosimetry method and P represents the porosity (%).

[0010a]

In an aspect, there is provided a polyolefin multilayer microporous membrane comprising:

at least first microporous layers which form both surface layers and at least a second microporous layer disposed between said both surface layers, wherein the static friction coefficient of one of said surface layers of said polyolefin multilayer microporous membrane against the other surface layer in longitudinal direction (MD) is 1.1 or less, wherein the average pore radius measured by mercury porosimetry method is 57 nm, wherein the pore density calculated from the average pore radius measured by mercury porosimetry method and the porosity, according to the formula below is 4 or more:

$$\text{pore density} = (P/A^3) \times 10^4$$

wherein A represents the average pore radius (nm) measured by mercury porosimetry method and P represents the porosity (%), and wherein said second microporous layer contains 35% by weight or more of ultra high molecular weight polyethylene.

[0011]

The polyolefin multilayer microporous membrane of the present disclosure preferably has a breakdown voltage of 1.4 kV/11.5 μm or more, and an air permeability of 250 seconds/100 cc or less.

[0012]

The polyolefin multilayer microporous membrane of the present disclosure preferably has an electrochemical stability of 65 mAh or less.

[0013]

In the polyolefin multilayer microporous membrane of the present disclosure, the second microporous layer preferably contains 35% by weight or more of ultra high molecular weight polyethylene.

[0014]

In the polyolefin multilayer microporous membrane of the present disclosure, the first microporous layers preferably contain 5% by weight or more of polypropylene.

[0015]

In the polyolefin multilayer microporous membrane of the present disclosure, the first microporous layers preferably contain 10% by weight or less of ultra high molecular weight polyethylene, and the second microporous layer preferably contains 35% by weight or more of ultra high molecular weight polyethylene.

EFFECTS

[0016]

The polyolefin multilayer microporous membrane of the present disclosure has good slip characteristics between membranes due to a static friction coefficient of not more than a specific value, and a high durability due to a dense microporous structure. When the polyolefin multilayer microporous membrane of the present disclosure is used as a battery separator, a battery having an excellent handleability in battery production

CLAIMS

1. A polyolefin multilayer microporous membrane comprising:

at least first microporous layers which form both surface layers and at least a second microporous layer disposed between said both surface layers, wherein the static friction coefficient of one of said surface layers of said polyolefin multilayer microporous membrane against the other surface layer in longitudinal direction (MD) is 1.1 or less, wherein the average pore radius measured by mercury porosimetry method is 57 nm, wherein the pore density calculated from the average pore radius measured by mercury porosimetry method and the porosity, according to the formula below is 4 or more:

$$\text{pore density} = (P/A^3) \times 10^4$$

wherein A represents the average pore radius (nm) measured by mercury porosimetry method and P represents the porosity (%), and wherein said second microporous layer contains 35% by weight or more of ultra high molecular weight polyethylene.

2. The polyolefin multilayer microporous membrane of claim 1, having a breakdown voltage of 1.4 kV/11.5 μm or more, and an air permeability of 250 seconds/100 cc or less.

3. The polyolefin multilayer microporous membrane of claim 2, having an electrochemical stability of 65 mAh or less.

4. The polyolefin multilayer microporous membrane of any one of claims 1 to 3, wherein said first microporous layers contain 5% by weight or more of polypropylene.

5. The polyolefin multilayer microporous membrane of any one of claims 1 to 4, wherein said first microporous layer and said second microporous layer have different composition from each other, and wherein the layer thickness ratio of the first microporous layer/the second microporous layer/the first microporous layer is from 0.05/0.9/0.05 to 0.3/0.4/0.3.

6. The polyolefin multilayer microporous membrane of claim 1 or 2, wherein said first microporous layers contain 10% by weight or less of ultra high molecular weight polyethylene, and said second microporous layer contains 35% by weight or more of