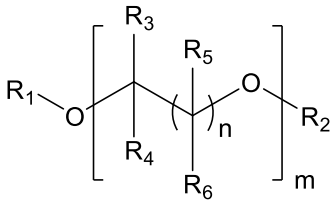
one or more dielectric compounds of formula (I):



(I)

wherein

m is an integer 1, 2, 3, 4 or 5;

n is an integer 1, 2, 3, 4 or 5;

R_1 is C_1-C_5 alkyl;

R_2 is C_6-C_{12} alkyl;

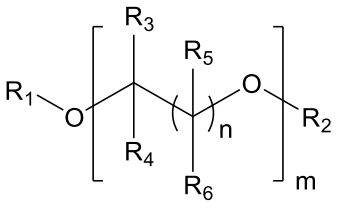
each R_3 and R_4 are independently selected from H and C_1-C_6 alkyl; and

each R_5 and R_6 are independently selected from H and C_1-C_6 alkyl;

the one or more dielectric compounds being present in a total amount in the range of 1 wt% to 100 wt%, based on the total weight of the thermal management fluid.

[0009] Another aspect of the disclosure provides a battery system. The battery system includes a housing; one or more electrochemical cells disposed in the housing; a fluid path extending in the housing and in substantial thermal communication with the one or more electrochemical cells; and a thermal management fluid of the disclosure as described herein disposed in the fluid path.

[0009a] In one aspect, the present disclosure provides a battery system comprising a housing; one or more electrochemical cells disposed in the housing; a fluid path extending in the housing and in substantial thermal communication with the one or more electrochemical cells; and a thermal management fluid disposed in the fluid path; wherein the thermal management fluid comprises one or more dielectric compounds of formula (I):



(I)

wherein

m is an integer 1, 2, 3, 4 or 5;

n is an integer 1, 2, 3, 4 or 5;

R_1 is C_1-C_5 alkyl;

R_2 is C_6-C_{12} alkyl;

each R_3 and R_4 are independently selected from H and C_1-C_6 alkyl; and

each R_5 and R_6 are independently selected from H and C_1-C_6 alkyl;

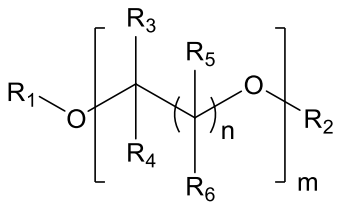
the one or more dielectric compounds being present in a total amount in the range of 1 wt% to 100 wt%, based on the total weight of the thermal management fluid; and

wherein the thermal management fluid has a flash point of at least 100 °C, measured in accordance with ASTM D93, and the thermal management fluid has a dielectric constant of at least 1.5 at 25 °C.

[0010] In another aspect, the disclosure provides an electric vehicle comprising the battery system of the disclosure as described herein.

[0011] In another aspect the disclosure provides a thermal management circuit including: a fluid path extending around and/or through a heat source; and a thermal management fluid of the disclosure, disposed in and configured to circulate in the fluid path and to absorb thermal energy produced by the heat source, wherein the fluid is disposed in the fluid path, the heat exchanger, the pump and the connecting duct.

[0011a] In another aspect, the present disclosure provides a thermal management circuit comprising: a fluid path extending around and/or through a heat source; a thermal management fluid disposed in and configured to circulate in the fluid path and to absorb thermal energy produced by the heat source, wherein the fluid is disposed in the fluid path, the heat exchanger, the pump and the connecting duct; wherein the thermal management fluid comprises one or more dielectric compounds of formula (I):



(I)

wherein

m is an integer 1, 2, 3, 4 or 5;

n is an integer 1, 2, 3, 4 or 5;

R_1 is C_1-C_5 alkyl;

R_2 is C_6-C_{12} alkyl;

each R_3 and R_4 are independently selected from H and C_1-C_6 alkyl; and

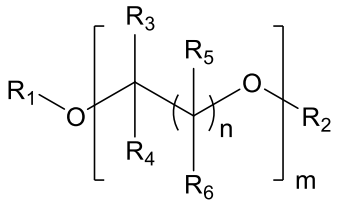
each R_5 and R_6 are independently selected from H and C_1-C_6 alkyl;

the one or more dielectric compounds being present in a total amount in the range of 1 wt% to 100 wt%, based on the total weight of the thermal management fluid; and

wherein the thermal management fluid has a flash point of at least 100 °C, measured in accordance with ASTM D93, and the thermal management fluid has a dielectric constant of at least 1.5 at 25 °C.

[0012] Another aspect of the disclosure provides a method including contacting a thermal management fluid of the disclosure with a surface having a temperature of at least 25 °C (e.g., at least 30 °C), the surface being in substantial thermal communication with a heat source; and absorbing thermal energy in the thermal management fluid from the heat source through the surface.

[0012a] In another aspect, the present disclosure provides a method comprising: contacting a thermal management fluid with a surface having a temperature of at least 25 °C, the surface being in substantial thermal communication with a heat source; and absorbing thermal energy in the thermal management fluid from the heat source through the surface; wherein the thermal management fluid comprises one or more dielectric compounds of formula (I):



(I)

wherein

m is an integer 1, 2, 3, 4 or 5;

n is an integer 1, 2, 3, 4 or 5;

R_1 is C_1-C_5 alkyl;

R_2 is C_6-C_{12} alkyl;

each R_3 and R_4 are independently selected from H and C_1-C_6 alkyl; and

each R_5 and R_6 are independently selected from H and C_1-C_6 alkyl;

the one or more dielectric compounds being present in a total amount in the range of 1 wt% to 100 wt%, based on the total weight of the thermal management fluid; and

wherein the thermal management fluid has a flash point of at least 100 °C, measured in accordance with ASTM D93, and the thermal management fluid has a dielectric constant of at least 1.5 at 25 °C.

[0013] Another aspect of the disclosure provides a method for preparing the thermal management fluid of the disclosure. Such method includes contacting a compound of formula (II)

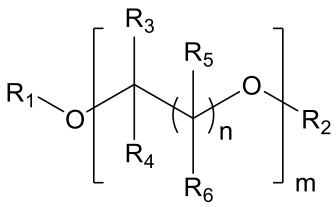
We claim:

1. A method comprising:

contacting a thermal management fluid with a surface having a temperature of at least 25 °C, the surface being in substantial thermal communication with a heat source; and

absorbing thermal energy in the thermal management fluid from the heat source through the surface;

wherein the thermal management fluid comprises:
one or more dielectric compounds of formula (I):



(I)

wherein
m is an integer 1, 2, 3, 4 or 5;
n is an integer 1, 2, 3, 4 or 5;
R_1 is C_1-C_5 alkyl;
R_2 is C_6-C_{12} alkyl;
each R_3 and R_4 are independently selected from H and C_1-C_6 alkyl; and
each R_5 and R_6 are independently selected from H and C_1-C_6 alkyl;
the one or more dielectric compounds being present in a total amount in the range of 1 wt% to 100 wt%, based on the total weight of the thermal management fluid; and

wherein the thermal management fluid has a flash point of at least 100 °C, measured in accordance with ASTM D93, and the thermal management fluid has a dielectric constant of at least 1.5 at 25 °C.

2. The method according to claim 1, wherein the heat source is an operating electrical component, e.g., a battery system, a capacitor, inverter, electrical cabling, a fuel cell, a motor, a computer, or high power charging equipment.

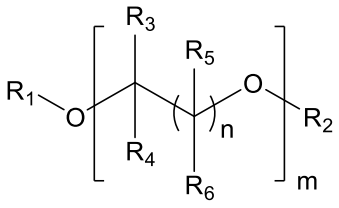
3. A battery system comprising:
a housing;
one or more electrochemical cells disposed in the housing;

a fluid path extending in the housing and in substantial thermal communication with the one or more electrochemical cells; and

a thermal management fluid disposed in the fluid path;

wherein the thermal management fluid comprises:

one or more dielectric compounds of formula (I):



(I)

wherein

m is an integer 1, 2, 3, 4 or 5;

n is an integer 1, 2, 3, 4 or 5;

R_1 is C_1-C_5 alkyl;

R_2 is C_6-C_{12} alkyl;

each R_3 and R_4 are independently selected from H and C_1-C_6 alkyl; and

each R_5 and R_6 are independently selected from H and C_1-C_6 alkyl;

the one or more dielectric compounds being present in a total amount in the range of 1 wt% to 100 wt%, based on the total weight of the thermal management fluid; and

wherein the thermal management fluid has a flash point of at least 100 °C, measured in accordance with ASTM D93, and the thermal management fluid has a dielectric constant of at least 1.5 at 25 °C.

4. A thermal management circuit comprising:

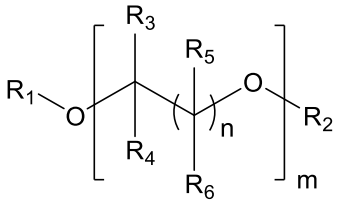
a fluid path extending around and/or through a heat source;

a thermal management fluid disposed in and configured to circulate in the fluid path and to absorb thermal energy produced by the heat source,

wherein the fluid is disposed in the fluid path, the heat exchanger, the pump and the connecting duct;

wherein the thermal management fluid comprises:

one or more dielectric compounds of formula (I):



(I)

wherein

m is an integer 1, 2, 3, 4 or 5;

n is an integer 1, 2, 3, 4 or 5;

R_1 is C_1-C_5 alkyl;

R_2 is C_6-C_{12} alkyl;

each R_3 and R_4 are independently selected from H and C_1-C_6 alkyl; and

each R_5 and R_6 are independently selected from H and C_1-C_6 alkyl;

the one or more dielectric compounds being present in a total amount in the range of 1 wt% to 100 wt%, based on the total weight of the thermal management fluid; and

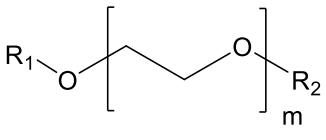
wherein the thermal management fluid has a flash point of at least 100 °C, measured in accordance with ASTM D93, and the thermal management fluid has a dielectric constant of at least 1.5 at 25 °C.

5. The method, battery system or thermal management circuit of any of claims 1-4, wherein R_2 is a branched C_6-C_{12} alkyl.

6. The method, battery system or thermal management circuit of any of claims 1-5, wherein each of R_3, R_4, R_5 and R_6 is independently selected from H and methyl.

7. The method, battery system or thermal management circuit of any of claims 1-5, wherein each R_4 is H and each R_3 is H or C_1-C_6 alkyl (such as C_1-C_4 alkyl or C_1-C_2 alkyl); and each R_5 is H and each R_6 is H or C_1-C_6 alkyl (such as C_1-C_4 alkyl or C_1-C_2 alkyl).

8. The method, battery system or thermal management circuit of any of claims 1-5, wherein R_3 is H, R_4 is H, R_5 is H and each R_6 is H or C_1-C_6 alkyl (such as C_1-C_4 alkyl or C_1-C_2 alkyl).

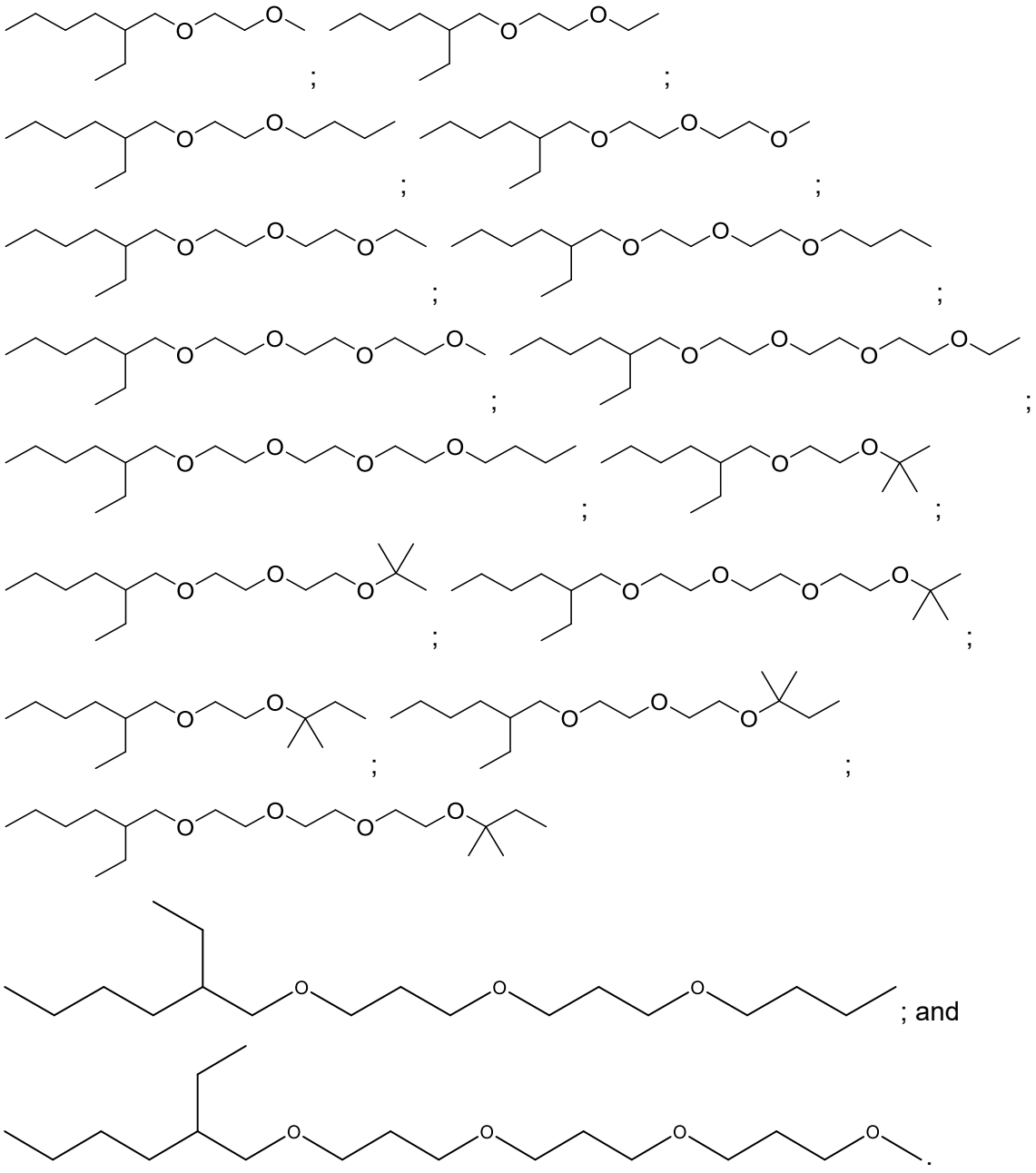
9. The method, battery system or thermal management circuit of any of claims 1-4, wherein the one or more dielectric compounds have the formula 

, in which m is 1, 2 or 3, R_1 is C_1-C_5 alkyl, and R_2 is C_6-C_{10} alkyl.

10. The method, battery system or thermal management circuit of any of claims 1-8, wherein m is 1, 2 or 3.

11. The method, battery system or thermal management circuit of any of claims 1-10, wherein each of the one or more compounds contains a total number of carbon atoms from 10 to 30.

12. The method, battery system or thermal management circuit of any of claims 1-4, wherein the one or more dielectric compounds are independently selected from:



13. The method, battery system or thermal management circuit of any of claims 1-12, wherein the one or more dielectric compounds is present in an amount in the range of 50 wt% to 100 wt%, based on the total weight of the thermal management fluid.

14. The method, battery system or thermal management circuit of any of claims 1-13, wherein the thermal management fluid has a kinematic viscosity at 40 °C in the range of 0.0000015 to 0.00002 m^2/s (1.5 to 20 cSt), as measured in accordance with ASTM D455.