regions and hydrophilic regions arranged alternately may be formed by imidazole rings serving as hydrophilic regions, and L_1 serving as hydrophobic regions. Such imidazolium main chain in an amphiphilic conformation may facilitate the antimicrobial activity of the polymer.

In the polymer of Formula (I), A_1 and A_2 may be, in each instance, same or different, and be independently selected from optionally substituted aryl. In preferred embodiments, A_1 and A_2 may be selected from C_8-C_{20} aryl group. The C_8-C_{20} aryl may be derived from an arene. The arene may be a monocyclic arene or a polycyclic arene. Preferably, the arene may be a monocyclic arene. Preferably, the monocyclic arene may be selected from benzene, methylbenzene, ethylbenzene, xylene, or diethylbenzene. In more preferred embodiments, A_1 and A_2 may be independently selected from xylylenediyl, which is an aryl group derived from diethylbenzene. In most preferred embodiments, A_1 and A_2 are same and are selected from ortho-xylylenediyl or para-xylylenediyl.

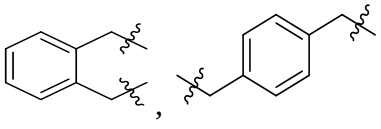
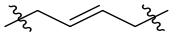
Advantageously, the polymer of Formula (I) where A_1 and A_2 are para-xylylenediyl may exhibit a shorter degradation period under neutral or acidic condition compared to the polymer where A_1 and A_2 are ortho-xylylenediyl. Under acidic condition, specifically at pH of 6, the half-life of the polymer having para-xylylenediyl groups may be about 60%-80% shorter than that of the polymer having ortho-xylylenediyl groups, showing a faster degradation speed. Under the condition of pH 8, the polymer of Formula (I) may display similar stability, where A_1 and A_2 groups may have less influences on the half-lives of the polymers.

In one preferred embodiment, L_1 may be provided where R_1 is H, R_2 is ethoxy, and A_1 and A_2 are para-xylylenediyl. In another preferred embodiment, L_1 may be provided where R_1 is H, R_2 is ethoxy, and A_1 and A_2 are ortho-xylylenediyl. In a further preferred embodiment, L_1 may be provided where R_1 and R_2 are methyl and A_1 and A_2 are para-xylylenediyl. In yet another preferred embodiment, L_1 may be provided where R_1 and R_2 are methyl, and A_1 and A_2 are ortho-xylylenediyl.

Advantageously, the present polymer of Formula (I) having the linker L_1 as described herein may exhibit retained or improved antimicrobial activity against a broad range of microbes and possess degradation properties under neutral or acidic condition compared to the known non-degradable antimicrobial analogues. In preferred embodiments, the minimum inhibitory

concentration (MIC) value of the polymer as described herein may be substantially equal to that of known non-degradable antimicrobial analogues. In more preferred embodiments, the MIC value may be at least 50%, or at least 75%, or preferably about 90% less than that of known non-degradable antimicrobial analogues.

In the polymer of Formula (I), L_2 may be, in each instance, selected from the group consisting of optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, and optionally substituted aryl. In embodiments, L_2 may be selected from optionally substituted alkenyl or optionally substituted aryl. The alkenyl may be a C_2-C_{16} alkenyl, a C_2-C_{12} alkenyl, more preferably a C_2-C_{10} alkenyl, most preferably a C_2-C_8 alkenyl. The C_2-C_8 alkenyl may be butenyl. Preferably, the butenyl may be 2-trans-butenyl or 2-cis-butenyl. The aryl may be a C_8-C_{20} aryl group. Preferably, the C_8-C_{20} aryl substituent may be xylylenediyl. In preferred embodiments, L_2 may be xylylenediyl or butenyl. In more preferred embodiments, L_2 is selected from the group consisting of:

, , and .

Advantageously, L_2 as described herein may provide a hydrophobic region to form an amphiphilic conformation in the present polymer. Without being bound to theory, this may further contribute to the antimicrobial activity of the polymer.

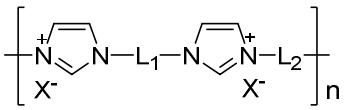
In the polymer of Formula (I), X may be, in each instance, same or different, and be a halogen. The halogen may be selected from the group consisting of chlorine, fluorine, bromine and iodine. In one embodiment, X is bromine.

In the polymer of Formula (I), n may be an integer of at least 1. Preferably, n may be an integer from 1 to 100, 1 to 50, 1 to 30, 1 to 15, 2 to 15, or 3 to 15. More preferably, n may be 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, or 15. Most preferably, n may be 7.

In embodiments, the polymer of Formula (I) as described herein may be selected from the group consisting of:

Claims

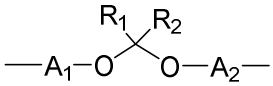
1. An oligomer or polymer having the following Formula (I):



Formula (I)

wherein

L_1 has the following structure:



wherein R_1 and R_2 are, in each instance, same or different, and are independently selected from the group consisting of hydrogen, optionally substituted alkyl, and optionally substituted alkoxy;

A_1 and A_2, are in each instance, same or different, and are optionally substituted aryl;

L_2 is, in each instance, selected from the group consisting of optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, and optionally substituted aryl;

X, in each instance, is same or different, and is a halogen;

n is an integer of at least 2;

or a salt or hydrate thereof.

2. The oligomer or polymer according to claim 1, wherein at least one of R_1 and R_2 is selected from C_1-C_8 alkoxy group.

3. The oligomer or polymer according to claim 2, wherein R_1 and R_2 are same or different, and are independently selected from hydrogen and ethoxy.

4. The oligomer or polymer according to claim 1, wherein R_1 and R_2 are, in each instance, same or different, and are independently selected from C_1-C_8 alkyl.

5. The oligomer or polymer according to claim 4, wherein R_1 and R_2 are methyl.

6. The oligomer or polymer according to any one of the preceding claims, wherein A_1 and A_2, are same or different, and are an aryl group derived from alkylbenzene.

7. The oligomer or polymer according to any one of the preceding claims, wherein A_1 and A_2, are same or different, and are xylylenediyl.

8. The oligomer or polymer according to claim 7, wherein said xylylenediyl is ortho-xylylenediyl or para-xylylenediyl.

9. The oligomer or polymer according to any one of the preceding claims, wherein R_1, R_2, A_1, and A_2 are provided in one of the following combinations:

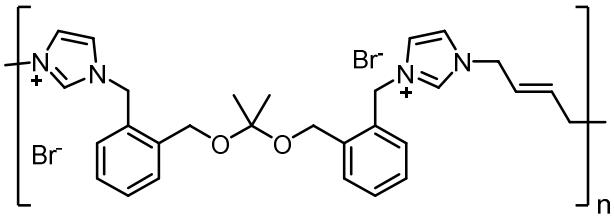
   R_1 and R_2 are methyl; and A_1 and A_2 are para-xylylenediyl;
   R_1 and R_2 are methyl, and A_1 and A_2 are ortho-xylylenediyl;
   R_1 is H, R_2 is ethoxy; and A_1 and A_2 are para-xylylenediyl; and
   R_1 is H, R_2 is ethoxy; and A_1 and A_2 are ortho-xylylenediyl.

10. The oligomer or polymer according to any one of the preceding claims, wherein L_2 is selected from the group consisting of alkenyl and aryl.

11. The oligomer or polymer according to any one of the preceding claims, wherein X is selected from the group consisting of chlorine, fluorine, bromine and iodine.

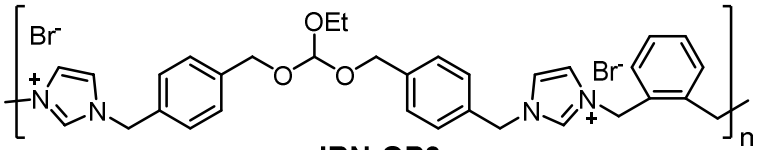
12. The oligomer or polymer according to any one of the preceding claims, wherein n is an integer from 1 to 100, 1 to 50, 1 to 30, 1 to 15, 3 to15, or 7.

13. The oligomer or polymer according to any one of the preceding claims, wherein the polymer is selected from the group consisting of:



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, and

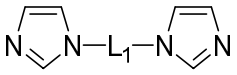


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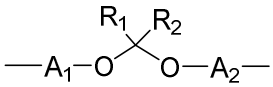
14. A method for preparing an oligomer or polymer according to any one of claims 1 to 13, comprising the step of:

contacting a di-imidazole having the following Formula (II):



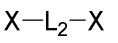
Formula (II)

wherein L_1 has the following structure:



wherein R1 and R2 are, in each instance, same or different, and are independently selected from the group consisting of hydrogen, optionally substituted alkyl, and optionally substituted alkoxy; and A1 and A_2, are in each instance, same or different, and are optionally substituted aryl;

with a dihalide having the following Formula (III):



Formula (III)

wherein L_2 is, in each instance, selected from the group consisting of optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, and optionally substituted aryl; and X, in each instance, is same or different, and is a halogen.

15. An antimicrobial composition comprising an oligomer or polymer according to any one of claims 1 to 13, or a salt or hydrate thereof.

16. A method for killing or inhibiting the growth of a microorganism, the method comprising contacting said microorganism *ex vivo* with an antimicrobial composition according to claim 15.

17. Non-therapeutic use of an antimicrobial composition according to claim 15, for killing or inhibiting the growth of a microorganism *ex vivo*.

18. An antimicrobial composition according to claim 15, for use as an antibiotic.

19. Use of an antimicrobial composition according to claim 15, in the manufacture of a medicament for treating a microbial infection.

20. The use according to claim 19, wherein the microbial infection is caused by one or more microorganism.

21. The method according to claim 16, use according to claim 17, or use according to claim 20, wherein the microorganism is a bacterium, fungus, or a mixture thereof.