Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

Case ID:M18-245L
Published: 4/9/2019

Inventors

Alexander Green
Abhishek Debnath
Sanchari Saha
Qing Hua Wang

Contact

Jovan Heusser
jovan.heusser@skysonginnovations.com

Materials with Exceptional Antimicrobial Activity

Antimicrobial resistance (AMR) is a major global public health threat, causing extended hospital stays and thousands of deaths each year. Healthcare settings, including hospitals, urgent care centers, ICUs, etc., contribute greatly to the spread of AMR as well as the development of new antibiotic-resistant microbes. Medical devices, such as catheters and endoscopes play a major role in healthcare associated infections (HAIs), and with the rise in AMR, these routine infections are costing healthcare systems billions of dollars and patients their lives. HAI prevention and improved antibiotic usage could help slow down the AMR epidemic, but these two have to be tackled aggressively.

Researchers at Arizona State University have developed novel biopolymer-encapsulated two-dimensional transition metal dichalcogenides (TMDCs) which exhibit exceptionally strong antimicrobial activity. Testing of the ssDNA-encapsulated TMDCs against strains of multidrug resistant bacteria, including a gram-negative "superbug" strain Escherichia coli resistant to 30 antibiotics and a gram-positive methicillin-resistant Staphylococcus aureus (MRSA) strain, show complete eradication of the bacteria at concentrations of 150 µg/ml and 80 µg/ml, respectively. Direct physical interactions with the bacteria causing disruptions in the cell membrane coupled with induction of ROS-independent oxidative stress create a multimodal mechanism of action (MOA) that is both highly effective and reduces the likelihood of future resistance. Furthermore, the TMDCs showed no cytotoxicity to human cell lines and negligible lysing of red blood cells, highlighting their biocompatibility. Given their potency and safety profile, these TMDCs could be a game changer in medical device coatings and the fight against HAIs.

Owing to their strong antimicrobial activity and multimodal MOA, these ssDNA-encapsulated TMDCs represent promising new materials for combating HAIs and the rise in AMR.

Potential Applications

- Antimicrobial materials (activity against a broad spectrum of pathogenic microorganisms including gram-negative and gram-positive bacteria and fungi)
  - Coating for medical devices (catheters, endoscopes, ventilators, IVs, duodenoscopes, implantable devices, etc.)
  - Incorporation in wound dressings/treatment

o Surface coatings (floors, tables, etc.) in healthcare settings to reduce the likelihood of HAIs

Benefits and Advantages

• Potent activity against multiple strains of gram-negative and gram-positive bacteria

o Successful eradication of three strains of MDR E. coli resistant to dozens of antibiotics at concentrations ranging from 80-150 μg/mL

• Multimodal MOA – ROS-independent induction of oxidative stress and cell wall disruption to induce death via cytoplasmic leakage

o Unique physical/cellular level MOA may reduce the risk of developing future drug resistance

• No cytotoxicity – toxic chemicals are not required in the preparation methods

• A variety of functional chemical moieties can be attached to the TMDC surface through versatile synthetic DNA chemistries

• The use of short synthetic ssDNAs enhances the antibacterial activity of the TMDCs by over an order of magnitude

For more information about this opportunity, please see

Fusion 2018 PDF Booklet - pg 26

For more information about the inventor(s) and their research, please see

Dr. Green's departmental webpage

Dr. Wang's laboratory webpage