BRG 4

The Use of Biopolymers Containing Selenium for Biofilm Prevention During Wound Healing

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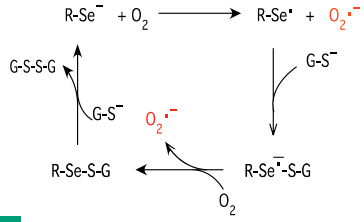
PURPOSE

Biofilm formation in a wound inhibits wound healing. Organo-selenium compounds attached to different biomaterials, such as bandages, have been shown to inhibit bacterial attachment, yet have no effect upon the surrounding tissue. **However, it is important to be able to incorporate the selenium directly into the polymer**. In this way there is more structural stability since wear would not remove the selenium from the surface and allow bacteria to bind to the new underlying surface.

INTRODUCTION

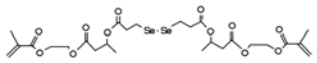
Organo-selenium is unlike other biocidal agents, such as silver ions, in that selenium can be covalently attached to various materials with no loss of catalytic activity and unlike conventional eluting coatings it does not produce a deleterious systemic effect. The equation below shows the catalytic mechanism of selenium. Selenium can continuously produce superoxide radicals by giving an electron to oxygen and taking one from sulfur compounds that are present in body fluids.



METHODS

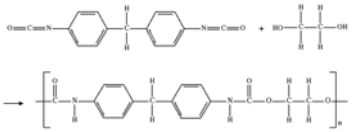
Two types of polymers were produced:

1. Methacrylates - **One of the methacrylates that was used for our initial studies [Se-3321] is seen below. This compound was synthesized as a diselenide. In this way the selenium is protected during the polymerization reaction and can be activated later by the addition of a thiol. Se-3321 need only be present in a small percentage of the methacrylate that does not contain selenium.**

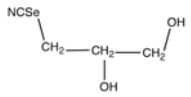


Se-3321

2. Polyurethanes – **Polyurethanes use the following type of chemistry.**

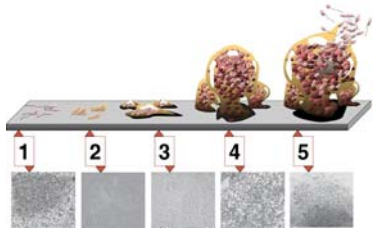


One of the monomers that contained selenium that was used to make the polyurethanes is the monomer seen below:



BACTERIAL BINDING ASSAY

The selenium-polymer was inoculated with bacteria (*Staphylococcus aureus* or *Pseudomonas aeruginosa*). After 24 hours growth in nutrient media, the number of bacteria that are attached to the polymer (colony forming units, CFU) are determined. Bacterial attachment was also evaluated by scanning electron microscopy (SEM). A dose response study to determine the amount of selenium necessary to inhibit bacterial attachment was performed. Toxicology studies were also performed with mammalian cells.



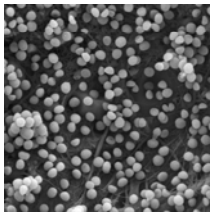
BIOFILM FORMATION ON A SURFACE

RESULTS

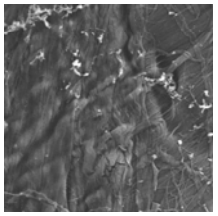
METHACRYLATE

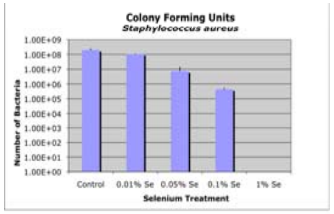
Staphylococcus aureus

Polymer No Se



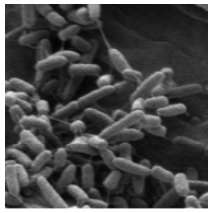
Polymer + 1% Se-3321



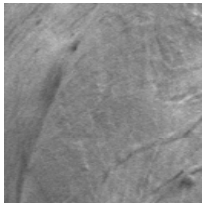


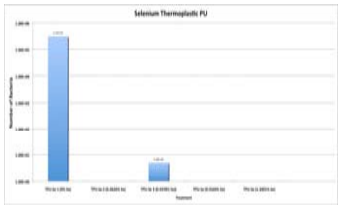
Pseudomonas aeruginosa

Polymer no Se



Polymer + 0.20% Se-3321

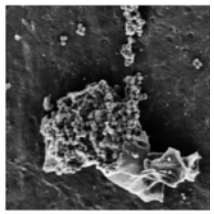




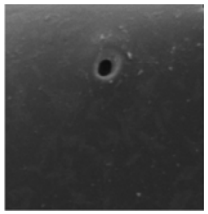
POLYURETHANE FOAM

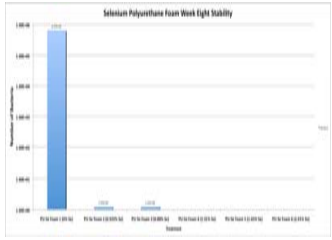
Staphylococcus aureus

Polymer No Se



Polymer + 1% Se





CONCLUSIONS

- Selenium monomers can be incorporated into different kinds of polymers suitable for medical bandages or devices.
- Selenium monomer incorporated in a polymer showed over 5 logs of inhibition of bacterial attachment.
- Incorporation of the selenium monomer into the polymer rather than just coating it on the surface a medical device, overcomes problems with surface wear, leaching or abrasion and allows for more flexibility in manufacture.
- The small concentrations required should not change the physical properties of the polymer.
- No toxicity was observed with mammalian cells.