Project ID: **64907**

Project Title: **"Green" Biopolymers for Improved Decontamination of Metals from Surfaces: Sorptive Characterization and Coating Properties**

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"Green" Biopolymers for Improved Decontamination of Metals from Surfaces: Sorptive Characterization and Coating Properties

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RESEARCH OBJECTIVE

The proposed research aims to develop a fundamental understanding of important biological and physical chemical parameters for effective decontamination of metal surfaces using environmentally benign aqueous-based biopolymer solutions. Understanding how heavy metal–chelating biopolymers coat and interact with contaminated surfaces will benefit the development of novel, safe, easy-to-apply decontamination methodologies for removal of radionuclides and heavy metals. The benefits of these methodologies will include the following:

- decreased exposure hazards for workers;
- decreased secondary waste generation;
- increased efficiency of decontamination;
- positive public appeal and development of novel, nature-friendly business opportunities; and
- lower cost of cleanup to the government.

We propose to use aqueous biopolymer solutions to coat a contaminated metal surface (i.e., steel), solubilize the heavy metals (e.g., uranium) from the surface, and bind the heavy metals into the biopolymer. The biopolymer coating (containing the immobilized hazardous metal contaminants) will then be removed as a viscous film, as a dry powder, or by washing. This "apply, wait, and remove" procedure will reduce the amount of worker time spent in decontamination activities.

RESEARCH PROGRESS AND IMPLICATIONS

This report summarizes work after 9 months of a 3-year project. The research aims to develop a fundamental understanding of important parameters for effective decontamination using aqueous biopolymer solutions. The work may be broken down into three parts: (1) selection and generation of cleaning agents; (2) characterization of material properties; and (3) study of transport properties. Both U and Cu will be used. Copper will be used as a model non-radioactive heavy metal to speed the laboratory studies in the first and second year. However, the critical experiments in the second and third year will be performed using depleted Uranium.

We have generated biopolymers for metal sorption screening by cultivation of algae (cyanobacteria). Algal strain include: *Nostoc* sp. strain GSV39, *Nostoc* sp. strain GSV40, *Nostoc muscorum* (collection of Ukrainian Institute of Hydrobiology), *Anabaena* (*Nostoc*) sp. strain PCC7120, and *Phormidium mucicola* SLR1. The cultures were grown in photobioreactor for 5 days with two different media, then left to mature (maturation leads to accumulation of copious polymers) for 1 month. Biomass was collected by filtration and dried at 80 deg C. Dry biomass was reconstituted in nitrate buffer and used for metal-binding experiments. Fig. 1 shows the abundant synthesis of biopolymers by algae (*Nostoc* sp. GSV40).

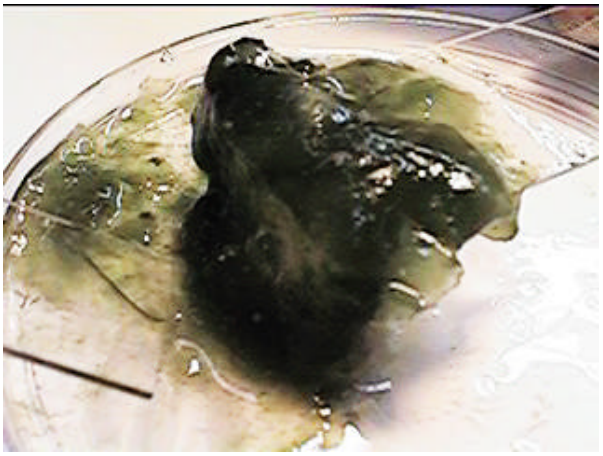

Fig. 1

A screening protocol for copper sorption has been developed using light absorbency. We have shown preliminary evidence of copper sorbtion from the nitrate buffer and are continuing the biopolymer screening. We have begun tests of biopolymers to coat surfaces. In Fig. 2, a bone-gel biopolymer was used to coat a glass slide and exposed to a solution of copper nitrate. The copper was sorbed from the solution into the gel on the surface – as shown by the blue tint. Algae are growing in shakeflasks in the background.

According to another report, (Bender et al., "Characterization of Metal Binding Bioflocculants produced by the Cyanobacterial Components of Mixed Microbial Mats," *Appl. Environ. Microbiol.*, **60**, 2311-2315 (1994)., the excretable biopolymer fraction can also serve as metal chelator. To study metal-binding properties of this fraction, excretable polysaccharides were precipitated from growth media with 2 volumes of cold ethanol. This fraction will also be analyzed for metal-binding properties.

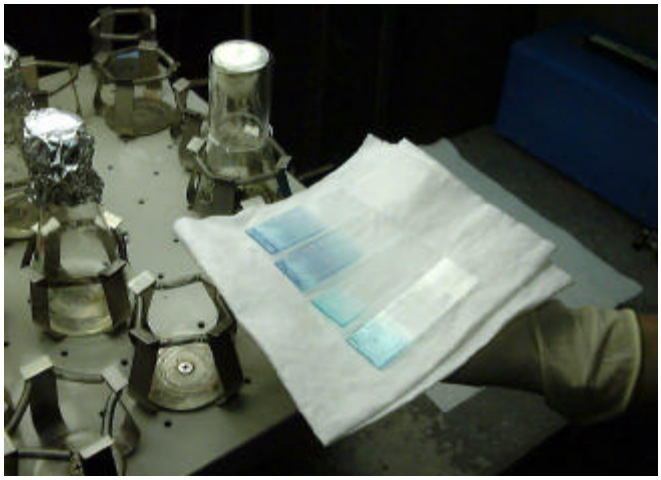

Fig. 2

PLANNED ACTIVITIES

Additional biopolymers will be screened and larger quantities of the best metal sorbents will be generated. We will continue tests of metal sorption with both Cu and U. The biopolymers will be used to coat metal contaminated coupons and tested for metal uptake. Spectroscopic and inductively coupled plasma spectroscopy (ICP) will be used to quantitate the isotherms. We will test the physical "gel" properties for use as a coating.

Tasks: Green Biopolymers	**Year 1**				**Year 2**				**Year 3**			
Selection/production of biopolymers												
Characterization of metal-chelation properties												
Metal removal from surfaces by biopolymer												
Methods of biopolymer surface application												

INFORMATION ACCESS

Green Biopolymers for Decontamination – poster presentation at “Workshop on integration of end user needs with research projects for EMSP: Focus on Deactivation and Decommissioning” at Savannah River Site on Nov. 17-18, 1998.

Abstract, “Green Biopolymer for Decon of Contaminated Surfaces” accepted for *Decontamination, Demolition and Restoration (DD&R) Topical Meeting on Site Restoration of government and Commercial Facilities*, Sep. 12-17, 1999, Knoxville, TN.