Eco-friendly applications of hot spring bacterial protein in terms of heavy metal (lead) decontamination and energy harvesting system

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Our planet has been suffering from extreme pollution for very long decades created by unscientific exposure to heavy metals and extreme burning of fossil fuels which become more dangerous to the life of all living objects on the planet. Therefore, to fight against environmental pollution, biomaterial based-technology such as environmental bacteria-based techniques acquire the most valuable importance because of their biocompatible, eco-friendly feature and low cost in comparison with other physical/chemical processes.

Therefore, we proposed a new eco-friendly green approach to remove non-biodegradable, toxic heavy metal, lead from aqueous solution using thermophilic bacterial protein as a bio-template. The hot spring bacterial MDH1 protein was induced into the solution of lead compound whereas lead was precipitated in the form of lead oxide nanoplates as viewed by the electron microscope and analyzed by inductively coupled plasma. The filtered supernatant doesn't exhibit any kind of toxic effect when applied to the growth of *E. coli* bacterium, implying a lead-free solution. And the as-formed lead oxide nanoplates were applied in dye degradation activity. The process is a clean and cost-effective one that can be used not only for the removal of lead contamination but also for the removal of different dyes from the environment.

We also demonstrate the concept and design principles of a biocompatible piezoelectric material with the assistance of thermophilic bacterial strain BKH2. The bacterial protein engineered the microstructure of organic polymer poly(vinylidene fluoride) (PVDF) in order to prepare the porous bio-organic films with increased biocompatibility, piezoelectric phase content, and crystallinity. The porous microstructure significantly enhances the piezoelectric coefficient and piezoelectric figure of merit of the bio-organic film compared with non-porous pure PVDF. The designed porous bio-organic film-based piezoelectric nanogenerator is capable to generate high output power and possesses favourable energy conversion efficiency which is further used for driving several LEDs and charge capacitors. With good biocompatibility and piezoelectric pressure sensitivity, the device was implemented for clinical applications of real-time healthcare monitoring from subtle pulse pressure waveform detection to vibrotactile information collection.

Signature of Supervisor with seal

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