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DNA bound Avicel Network: The Beginnings of a Self-Healing Material

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ABSTRACT

Self-healing materials could potentially provide many improvements to engineering projects, including reduced maintenance and cost, and increased lifespan. It is desired to create a self-healing material proof of concept, which can then be altered for eventual application to the surfaces of small satellites with the goal of increasing material lifetimes. The intrinsic properties and abilities of DNA base pairing will be studied as a first test of proof of concept. The exploratory research reported in this short communication utilizes oxidation of small (50µm) particles of Avicel using TEMPO, followed by activation of Avicel particles via an EDC (1-Ethyl-3-(3-dimethylaminopropyl) carbodiimide hydrochloride) reaction. The cellulose prepared in this manner will next be reacted with short sequences of single stranded DNA (oligonucleotides) with the cellulose, although this has not yet been achieved. Complementary strands will be bound to a second aliquot of particles. The particles will be combined to test if they hybridize (bind in a directed manner), resulting in a network of Avicel particles glued together by DNA. A Malvern wet particle size instrument was used to determine zeta potential of the cellulose particles, and in the future will be used to compare the size of particles before and after chemical alterations. Colored nanoparticles will be used to dye the individual aliquots of the derivatized celluloses so that a change in color may be observed when cellulose derivatized with complimentary strands of DNA are brought in contact with each other. After washing to remove unbound particles, a change in color would be expected to occur, thus indicating binding. While this is a work in progress, key developments at this point are the experimental design, development of research hypotheses, and successful oxidation of cellulose. These experiments are part of a longer term project that is studying whether intrinsic self-healing materials are possible. Alterations in the particle and in binding sequences to be placed on the particles have potential for automobile, airline, satellites and spacecraft, military, and healthcare applications, where self-healing principles at a nano-scale would enable micro-damage to be identified and healing processes to occur.

KEYWORDS

Avicel, cellulose, DNA super glue, self-healing material, materials science, smart materials