Organic Chemistry: An Indian Journal

Opinion | Vol 15 Iss 10

Halloysite Nanotubes, Nucleotides, and DNA Study: Easy Fabrication of Natural Polyelectrolyte-Nanoclay Composites

Ross Jones*

Editorial Office, Organic Chemistry: An Indian Journal, UK

***Corresponding author:** Ross Jones, Editorial Office, Organic Chemistry: An Indian Journal, UK, E-mail: organicchem@journalres.com

Received: October 07, 2021; **Accepted:** October 18, 2021; **Published:** October 29, 2021

Opinion

The ability of biopolymers to function as materials building blocks can be considerably influenced by their complexation with Halloysite Nanotubes (HNTs). We investigated the manufacture of halloysite nanotubes compounds with nucleotides and genomic DNA in this study. UV spectroscopy was used to examine the binding of DNA and other nucleotide species (polyAU, UMP Na2, ADP Na3, dATP Na, AMP, uridine, and ATP Mg) to halloysite nanotubes. Different nucleotide binding to the nanoclay varied but was minimal in both the presence and absence of MgCl2; however MgCl2 considerably improved the binding of longer molecules like DNA and polyAU. Measurements of potentials confirmed that the nanotubes had been modified with DNA and nucleotide species. Transmission Electron Microscopy (TEM), atomic force microscopy (AFM), and hyperspectral microscopy were used to examine DNA-Mg-modified nanotubes. Thermogravimetric analysis confirmed DNA sorption by the nanotubes, and changes in the surface adhesion force determined by AFM suggested the presence of DNA on the nanotube surface. After adding phosphate buffered saline, DNA bound by halloysite in the presence of MgCl2 might be partially freed. MgCl2 concentrations (10 mM-100 mM) were used to assess DNA binding and release from halloysite nanotubes. DNA sorption to halloysite was greatly boosted even at low MgCl2 concentrations, and the binding was levelled out at about 60 mM. Evaporation-induced self-assembly was employed to generate a regular pattern on a glass surface using DNA-Mg-modified halloysite nanotubes. The spiral-like design that was created was extremely sturdy and did not dissolve when water was added. The findings, which include the alteration of non-toxic clay nanotubes with a natural polyanion DNA, will be used to create gene delivery vehicles as well as halloysite self-assembly on various surfaces (such as skin or hair). In recent years, clay-based composite materials have found a wide range of uses, opening up new possibilities in materials science and biology. The ability to controllably self-assemble on planar and three-dimensional surfaces and fabricate porous clay-doped polymer composites, which can be used in tissue engineering, artificial cell shellization, and hair surface engineering, is enabled by tailoring diverse biopolymers to clay particles. Because of its potential to overcome cancer and serious genetic illnesses (such as neurodegenerative diseases or blood and immunological abnormalities) that were long thought to be incurable, gene therapy is considered one of modern medicine's greatest triumphs. Despite rapid progress and encouraging outcomes, significant questions concerning the safety of gene treatments based on modified viral vectors persist. As a result, non-viral vectors have been developed based on liposomes, polycations, metal nanoparticles, copolymers, and other materials that are less toxic and perhaps more effective than viral vectors. As a result, a transfection vector based on thiolated poly (ethylene glycol)-poly(l-lysine) block copolymer (PEG-PLL) that responded to the reductive situation and mimicked the intracellular environment was produced. All of these systems have their own set of benefits and drawbacks, but one of the biggest issues is that existing non-viral DNA delivery methods are still inefficient. As a result, the quest for novel non-toxic, potent non-viral candidates capable of DNA transport into mammalian cells continues, with clay nanoparticles being explored as a possible candidate. Clay minerals like montmorillonite, illite, and kaolinite have been proposed as potential DNA delivery vectors due to their excellent capacity to bind and protect DNA from degradation, as well as their ability to alter soil microorganism cells. Furthermore, clay minerals are generally non-toxic and have been used by humans

Citation: Jones R. Halloysite Nanotubes, Nucleotides, and DNA Study: Easy Fabrication of Natural Polyelectrolyte-Nanoclay Composites. Org Chem Ind J. 2021;15(10):44

for medical purposes since ancient times as a remedy for various gastrointestinal diseases, such as diarrhoea, or to avoid poisoning. Montmorillonite is the clay mineral that has been investigated the most in terms of nucleic acid binding.

It proved to be an excellent defender of orally delivered DNA from stomach acidic conditions and DNA-degrading enzymes, allowing plasmid DNA transport into mural small intestine cells. Although halloysite nanotubes have already been reported as a promising medicine and cosmetic carrier and successfully exploited for tissue engineering applications, the DNA-binding capabilities of halloysite have not been adequately investigated compared to other clays. Because of the oppositely charged outer and inner surfaces, halloysite nanotubes are a clay mineral with unique properties that can be used to bind a variety of macromolecules. The cation exchange capacity of halloysite has been found to range from 0.1 mol/kg to 0.7 mol/kg. The charge, colloid stability, lumen size, and stimulus responsiveness of halloysite nanotubes can all be altered further. Antimicrobial dyes, paclitaxel, curcumin, antibiotics, and cell labelling agents have all been delivered using halloysite nanotubes as nanocontainers. It was recently proposed that halloysite nanotubes-carbon dots hybrids be used as non-viral vectors for oral gene transfer. Some attempts were made to customise halloysite with DNA by grafting the nanotubes with Polyethyleneimine (PEI), Aminopropyltriethoxysilane (APTES), or polyamidoamine, which is a highly damaging approach that is scarcely compatible with focused gene delivery technique. Unfortunately, most polycations, including PEI, are cytotoxic, prompting us to devise a simple method for easily modifying halloysite clay nanotubes with DNA while avoiding the need of potentially harmful additions. Here, we present our findings, which show that halloysite may be efficiently labelled with nucleic acids, allowing for further usage of halloysite in biotechnology. We also show how DNA-halloysite hybrids self-assemble on surfaces, which could be useful in hair surface engineering.