J & A TECHNOLOGY

Natural Clays

Review of NSP Biofunctions and Applications

From ancient clay to 21st century NSP (JJ Lin 2003)

(the hidden treasures of the sand) – the Bible Deuteronomy 33:19)

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2020-8

The History of Natural Clays and Applications

Historically, clay eating has been associated with treatments for cholera and bacterial infection and more examples---

1. The first recorded use of medicinal clay is on Mesopotamian clay tablets around 2500 B.C. Ancient Egyptians used clays as **antiseptics** and **preservative** for making mummies.
2. Aristotle (384–322 BC) made the first reference to the deliberate eating of earth, soil, or clay by humans (for **therapeutic and religious purposes).**
3. Marco Polo described how in his travels he saw Muslim pilgrims cure **fevers by ingesting** 'pink earth' to **relieve famine.**
4. Dating back to Greek , **holy clay tablets** were widely traded as cures for poison and the plague; and also used in the Roman Catholic Church.

"Smart" Parrots Lick Clays

Many species of South American parrots have been observed at clay licks, ingesting clays in Papua New Guinea. These **parrots** regularly eat seeds and unripe fruits containing **alkaloids and other toxins**. Because many of these chemicals become **positively charged in the acidic stomach**, they bind to clay minerals which have **negatively charged** cation-exchange sites, and are thereby rendered safe.

. (adopted from Geophagia Wikipedia)

Bentonite: The Raw Material of NSP in 2003

Bentonite: Used by the NASA space program in 1960s as the calcium supplements

A mountain of clay--Petrified Forest National Park, Arizona. (adopted from Medicinal clay; Wikipedia)

The effects of weightlessness on human body were studied by NASA in the **1960s**. Experiments demonstrated that weightlessness leads to a rapid bone depletion. A number of pharmaceutical companies were asked to develop calcium supplements, "**the calcium in clay ...is absorbed more efficiently ..** [clay] contains some factors promoting calcium utilization and/or bone formation."

Modern uses of the natural clays

11 benefits of bentonite clay: https://www.medicalnewstoday.com/articles/325241

- Pharmaceutical formulations, Oral, Gastrointestinal protectors
- Osmotic oral laxatives
- Anti-diarrheal, detoxifying-removing toxins
- Industrial absorbents
- Dermatological protectors
- Cosmetics, skin treatment
- Drug excipients and in the liberation process of drugs

The History of Natural Clays and Applications

From ancient clay to 21st century NSP (JJ Lin 2003)

From Egyptian uses of clays for anti-inflammatory, antiseptics and as preservative for making mummies, cures for poison and plague, to NASA space program in 1960's for calcium supplement, to the modern 21st century, scientists are still searching the way of utilizing clay for the "holy grail" material as alternatives to protect mankind and the environment. Although the endeavor is still continuing, we may be a step closer as our research outlines in this account.

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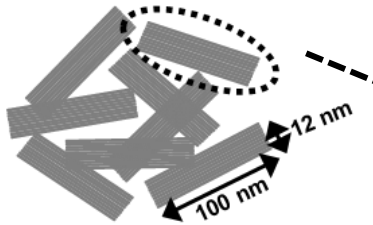
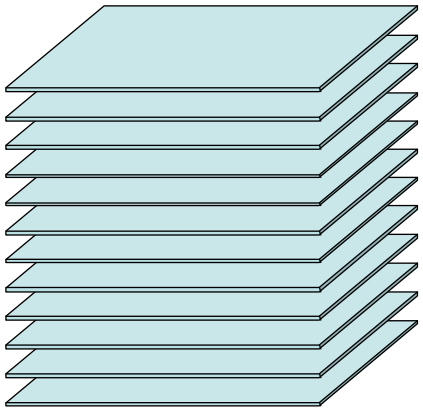
2020-3

Invention of making Nanoscale Silicate Platelets (NSP) from natural clay of microscale layered structure (JJ Lin 2001-2003)



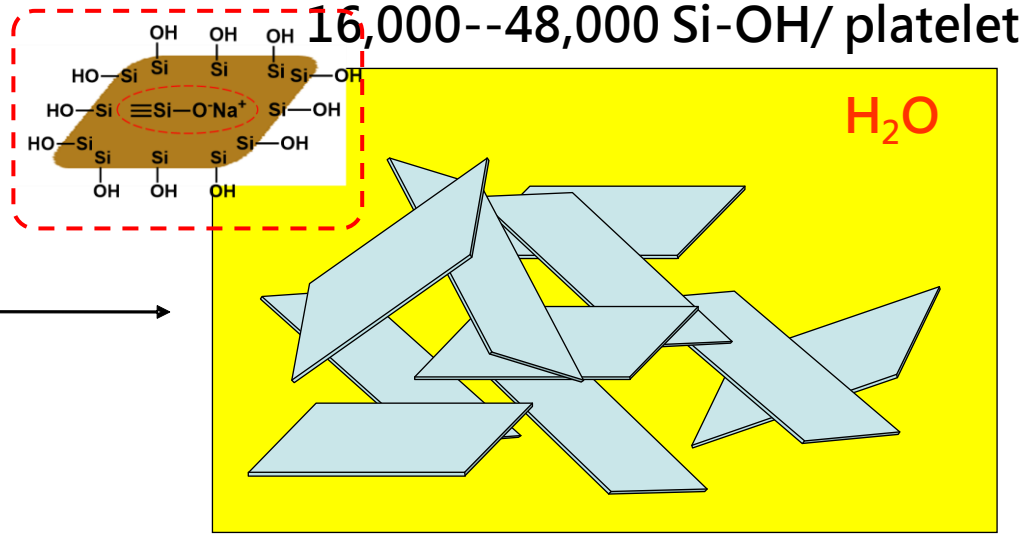
Aggregates

Natural silicate minerals (clays)



(Layered structure)

NSP
Dimension: 100 x 100 x1 nm
18,000 Si-O$^-$Na$^+$/ platelet
16,000--48,000 Si-OH/ platelet



1.0 nanometer-thin silicate plates in water (dispersible)

US Patents: 7 125 916 B2 (2006); 7 442 728 B2 (2008); 7 495 043 B2 (2009); 8 168 698 B2 (2012) to NCHU and NTU "Method for Producing Nano Silicate Plates".
JJ Lin. "Intercalation strategies in clay/polymer hybrids, Progress in Polymer Science (Review Article)(2014)
JJ Lin. "First Isolation of Individual Silicate Platelets from Clay Exfoliation" and Their Unique Self-Assembly into Fibrous Arrays, The Journal of Physical Chemistry B, (2006)

New Compositions –-NSP
–ionic character (anionic)—
1.0-nanometer-thickness!
---high surface 750 m2/g ---

Safety and Low Toxicity of NSP

ARTICLE

Evaluation on Cytotoxicity and Genotoxicity of the Exfoliated Silicate Nanoclay

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ABSTRACT The concern about toxicity for nanosilicate platelets (NSP) derived from natural montmorillonite clay is addressed. The NSP nanoclay was isolated from polyamine−salt exfoliation of the layered silicate clay into randomized individual plates, possessing multiple ionic charges on the surface of silicate plates with an average geometric dimension of ca. 80 × 80 × 1 nm^3. The material had been previously shown to be effective for antimicrobial and tendency for adhering onto the biomaterial surface based on the direct observation by using scanning electron microscope. The material safety on genotoxic effect was investigated by using three different test systems: the Comet assay test on Chinese Hamster Ovary (CHO) cells in vitro, micronucleus (MN) assay in vivo and the *Salmonella* gene mutation assay on strain TA98, TA100, TA102, TA1535 and TA1537. The Comet assay showed no DNA damage after 24 h of incubation with NSP of 1000 μg/mL. The MN test indicated no significant micronucleus induction in the CHO cells at the concentrations tested. With all five strains of *Salmonella typhimurium*, none of mutations was found. Furthermore, cytotoxicity of the same material was assayed by 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) and lactate dehydrogenase (LDH) release, showing a low cytotoxicity on CHO cells below 1000 μg/mL after 12 h incubation period and a dose-dependent effect after 24 h incubation. For feeding to rats, the acute oral toxicity was shown a low lethal dose (LD_{50}) or greater than 5700 mg/kg body weight for both male and female Sprague-Dawley rats. Overall, the study has demonstrated the safety of the NSP for potential uses in biomedical areas.

KEYWORDS: nanosilicate platelets • cytotoxicity • genotoxicity • nanomaterials • acute oral toxicity

The safety of NSP with respect to cytotoxicity and genotoxicity has been evaluated.

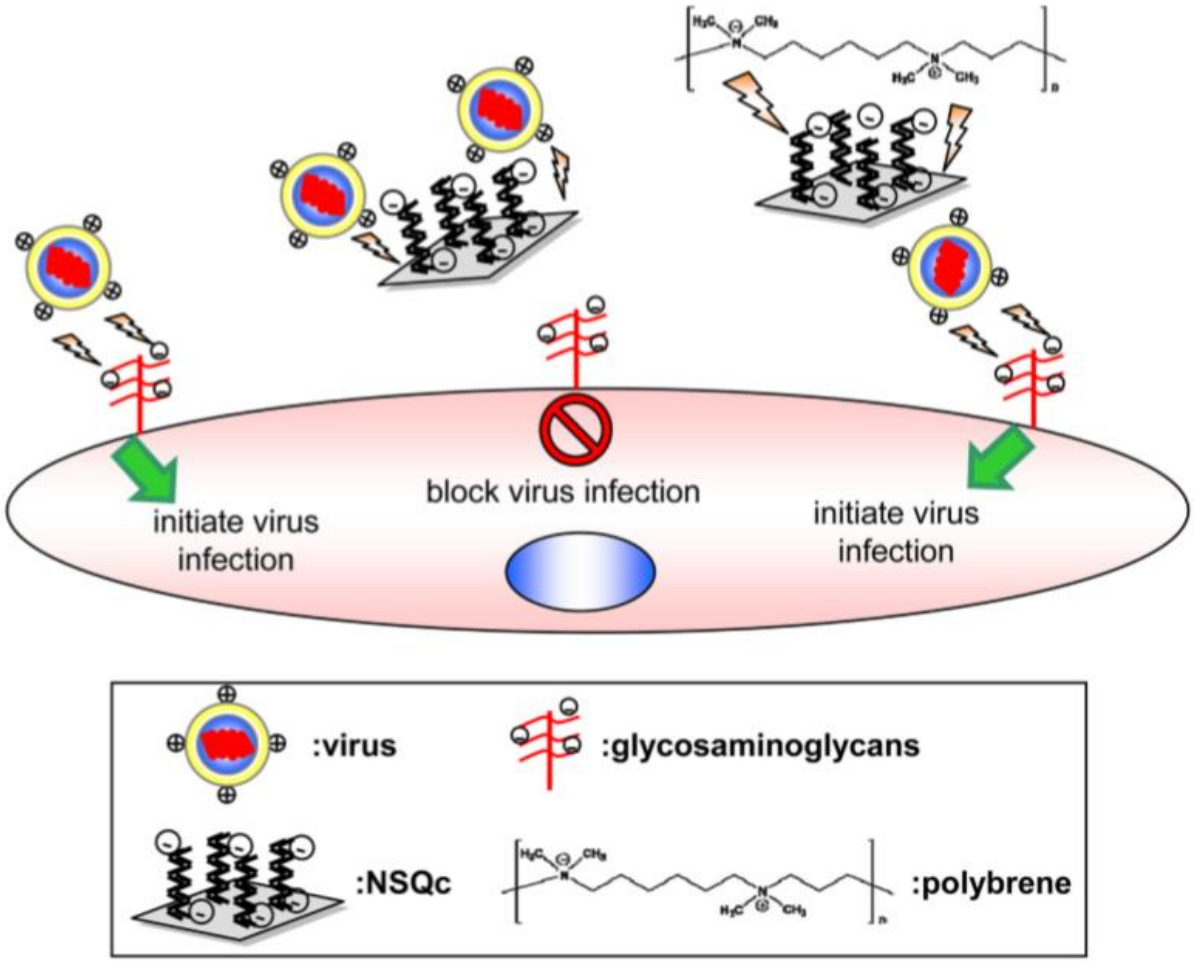
1. A low lethal dose (**LD_{50} > 5,700 mg/kg or similar to NaCl**) was found.

2. Low cytotoxicity (1000 ppm on CHO cells) and none of genotoxicity were reported.

Lin and Peng, ACS Applied Materials and Interfaces, 2 (6), **2010**, 1608

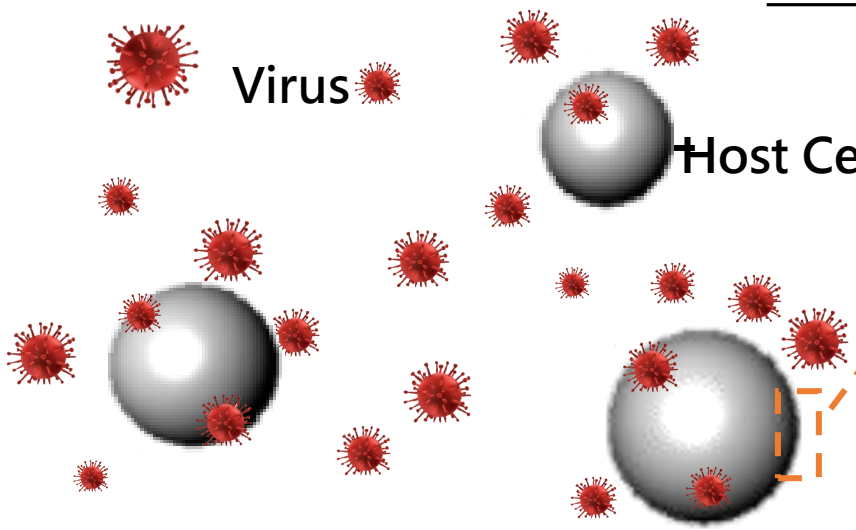
Prevention of Virus-Infection by SDS-Modified NSP Enabling a Physical Shielding Mechanism (2014)

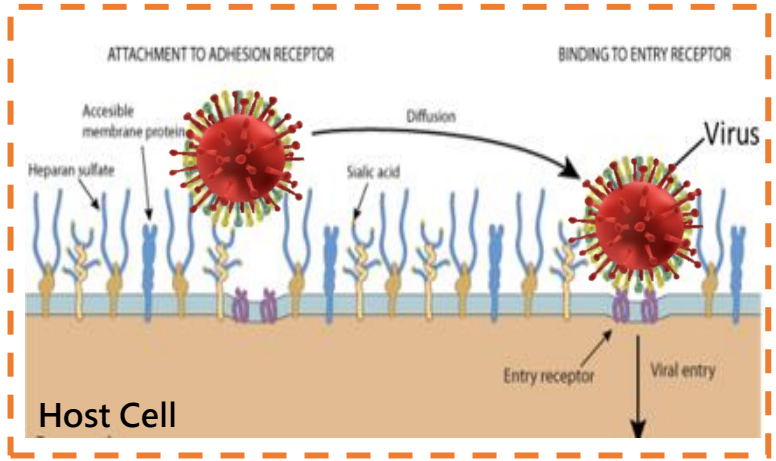
Jian-Jong Liang, Jiun-Chiou Wei, Yi-Ling Lee, Shan-hui Hsu*, **Jiang-Jen Lin*,** and Yi-Ling Lin*, **2014.** Surfactant- modified nanoclay exhibits an **antiviral activity with high potency and broad spectrum,** Journal of Virology, 88, 4218-4228.



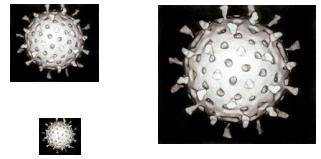
Antivirus by NSP Shielding
Physically capturing virus by opposite charge attraction between NSP and virus

JJ Lin, Journal of Virology 2014

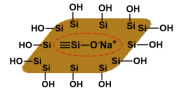




Size compatibility

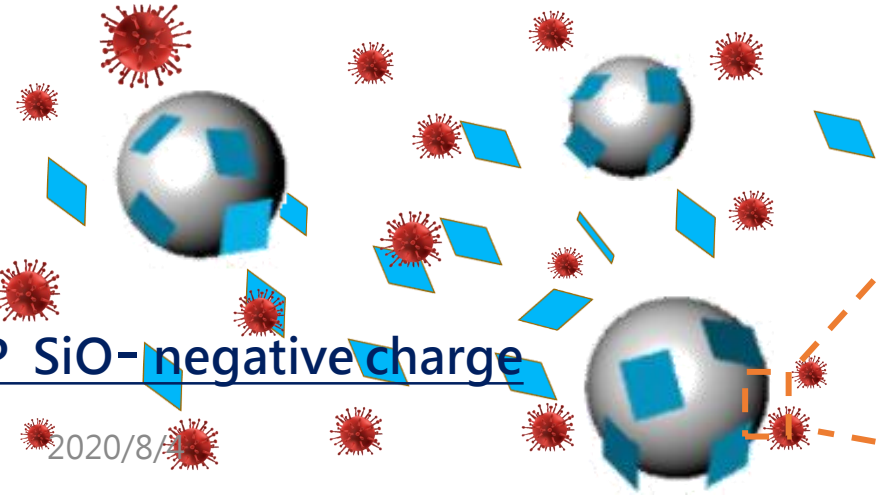


virus (20-100-400 nm)



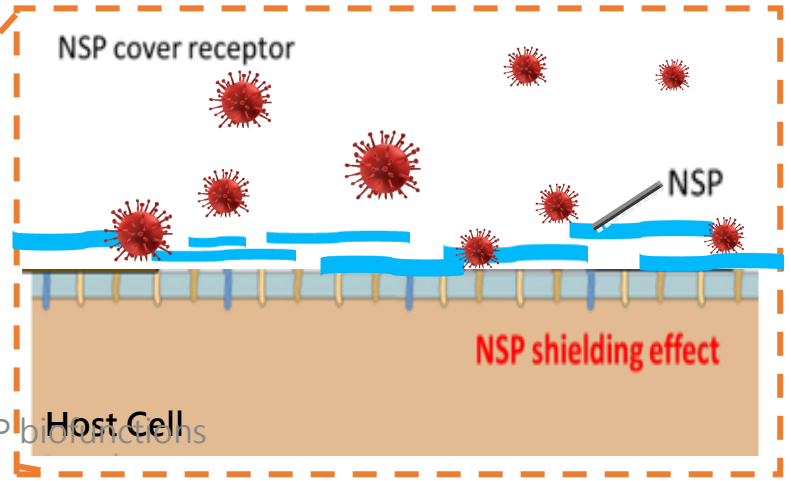
NSP 100 x 100 x 1 nm

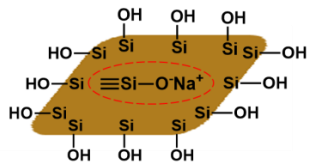
NSP intercept incoming virus



NSP SiO⁻ negative charge

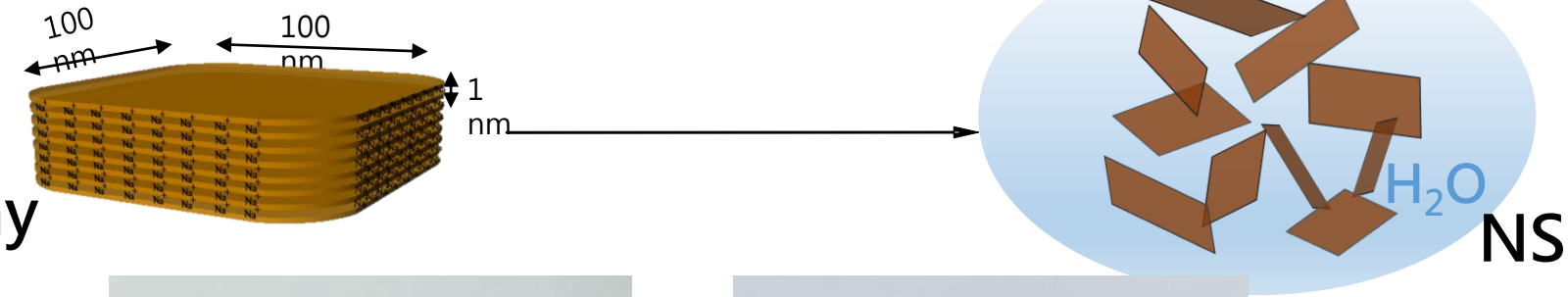
NSP adhere on host-cell surface shielding off virus attacking receptors





NSP single platelet
100 x 100 x 1 nm
18,000 Si-O⁻Na⁺
16,000-48,000 Si-OH

NSP Availability and Affordability
NSP in water (6-10 w% vs. 3 w %)
Concentrated Solution



Bentonite clay

NSP

Video inside:
Showing a shear force dependent viscosity and convenient storage

Estimated NSP Affordability: diluted to 100 ppm for spray (100 US$/ton)

Economically calc. based on 10-ton reactor scale-up

(further dilution to 100-1000 ppm effective level for large-area spraying, instantly formed THIN layers for protective shielding effect)

NSP can help NOW during the COVID-19 pandemic

Problem:

- There is a shortage of PPE (personal protective equipment) for the front line medical workers.
- Many are reusing their PPE and putting themselves at risk to be infected.
- With a shortage of personnel and PPE, our healthcare systems will be overwhelmed and people will die.

A possible solution:

NSP or Bentonite in water dispersion can be sprayed on masks and other PPE that are needing to be reused. By doing so, the physical "shielding" off the virus *could* provide the additional protection from infection. As NSP have had considerable research to support its uses and safety, this seems like a simple solution to the global problem of pandemic.

For further consultation

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