ダイヤモンドナノ粒子の医療応用

AUTHOR(S):

Yu, Jie; Fu, Xinyi; Han, Xu

CITATION:

Yu, Jie ...[et al]. ダイヤモンドナノ粒子の医療応用. 京都大学アカデミックデイ2023 : 研究者と立ち話（ポスター/展示） 2023: 16.

ISSUE DATE:

2023-09-24

URL:

http://hdl.handle.net/2433/285943

Nanodiamond for Biomedicine

ダイヤモンドナノ粒子の医療応用

京都大学　大学院人間・環境学研究科　物質科学講座　博士課程2年　　Yu Jie（余　杰）

Introduction　研究の背景

◆ What is nanodiamond? (ナノダイヤモンドとは)

- Diamond is a form of carbon materials
(ダイヤモンドは炭素材料の一種です)
- Nanodiamond is diamond with a size below 100 nanometers
(ナノダイヤモンドは100ナノメートル以下の大きさのダイヤモンドです)

Different form of carbon materials

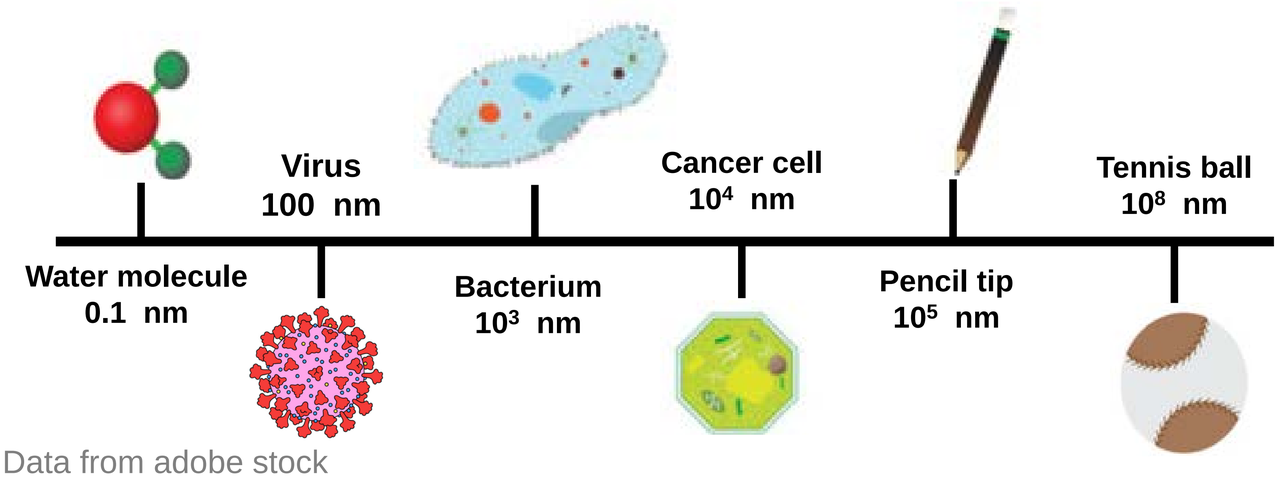
Coal

Pencil

Diamond

* Data from Wikipedia

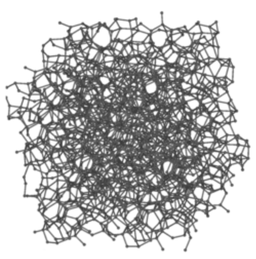
Nanometer scale



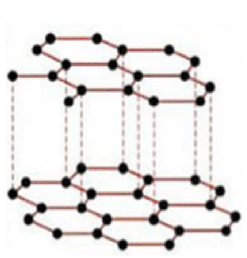
* Data from adobe stock

- Difference in chemical structures
(化学構造の違い)

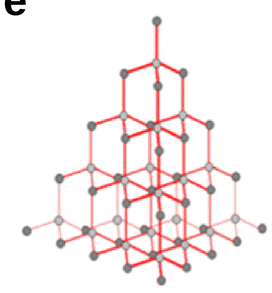
Chemical structure



Amorphous carbon



Graphite



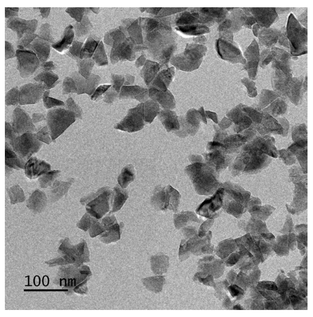
Diamond

* Data from Wikipedia

Diamond & nanodiamond

Diamond mineral

Nanodiamond image



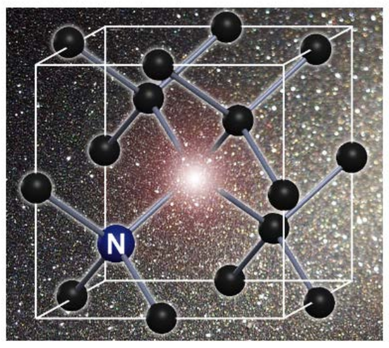
transmission electron microscope image

* Data from sustainable nano

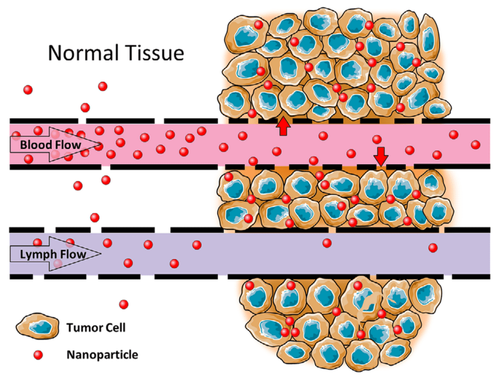
◆ What are the advantages of nanodiamond in biomedicine? (医療応用におけるナノダイヤモンドの利点は何ですか)

- Superior hardness, fluorescence
優れた硬度、蛍光特性
- Chemical stability of core, tailorable surface chemistry
コアの化学的安定性、表面修飾可能
- Nanometer size, non-toxicity
小さい、毒性が無い

Nitrogen-vacancy center makes nanodiamond fluoresce



Nano size allows particle to accumulate in tumor tissue

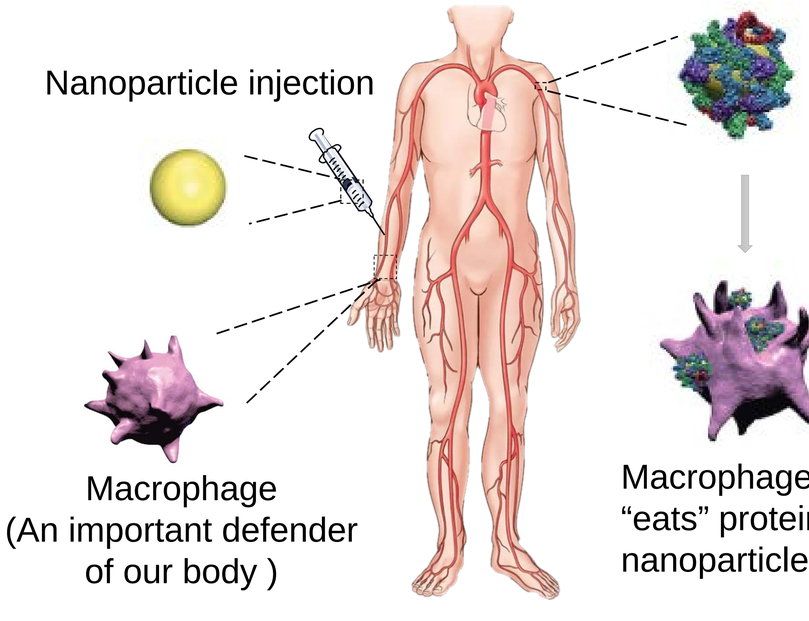


Adv. Therap. 2020, 2000203

◆ What are limitations of nanodiamond in biomedicine? (医療応用におけるナノダイヤモンドの限界は何ですか)

- Easy to aggregate
凝集しやすい
- Poor dispersibility in water
水への分散性が低い
- Protein corona formation
タンパク質コロナの生成
- Non-selectivity to malignant tumor cells
悪性腫瘍細胞への選択性が無い

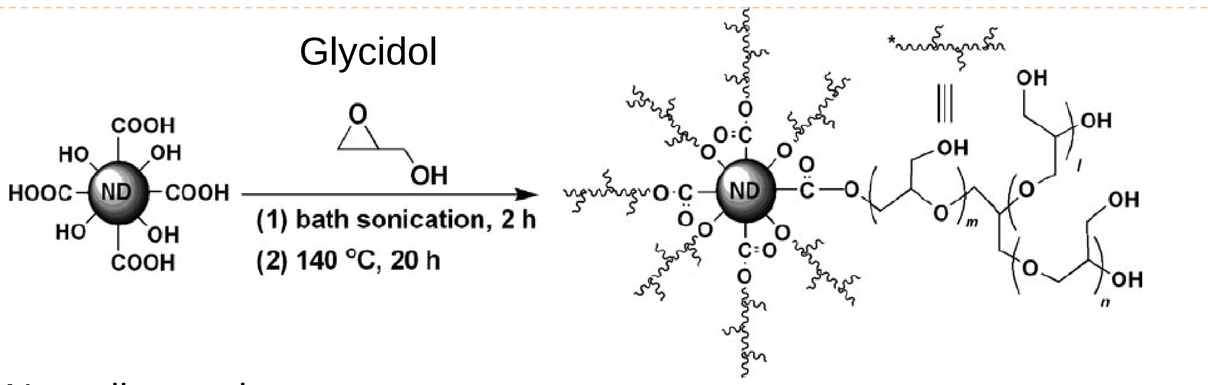
Protein corona: proteins that spontaneously adsorb on the surface of nanodiamond once it in contact with blood



Our research　我々の研究

◆ Polyglycerol coating —— invisible cloak for nanodiamond （ポリグリセロールコーティング——ナノダイヤモンドの透明マント）

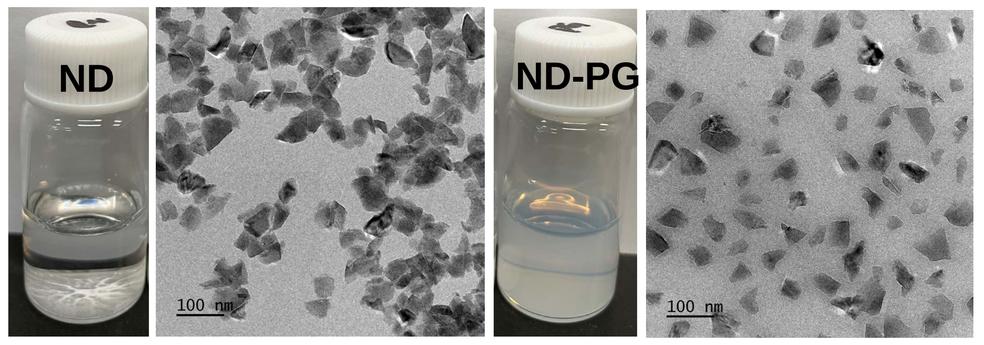
- Synthesis route (合成法)



Nanodiamond **(ND)**

Nanodiamond with polyglycerol coating **(ND-PG)**

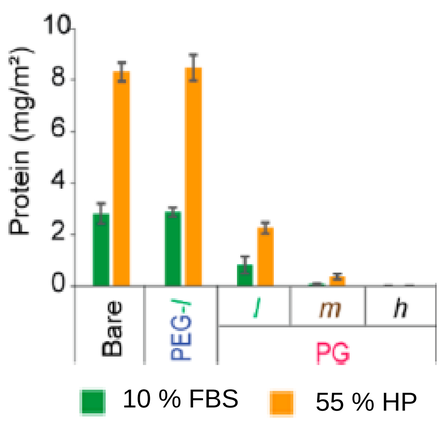
- Good dispersibility in saline and no aggregation after PG coating (PGコーティングにより生理食塩水への高い分散性)

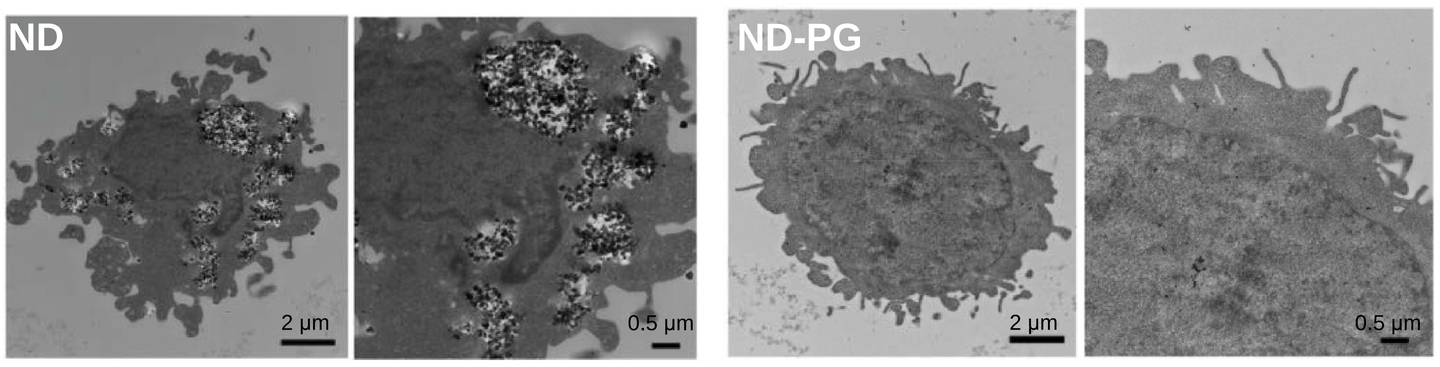


transmission electron microscope image

- PG coating prevents protein corona formation and clearance by macrophage
（PG コーティングはタンパクコロナの形成とマクロファージによるクリアランスを防止します）

We incubated ND (bare), ND with polyethylene glycol coating (PEG-l), and ND with different amount PG coating (PG: low, medium, high) with 10% fetal bovine serum (FBS) or 55% human plasma (HP). Then we separated and quantified the protein amount on each NDs.



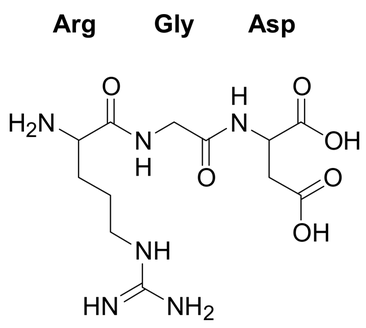


We incubated human macrophage cell with ND and ND-PG and then used transmission electron microscope to observe cells.

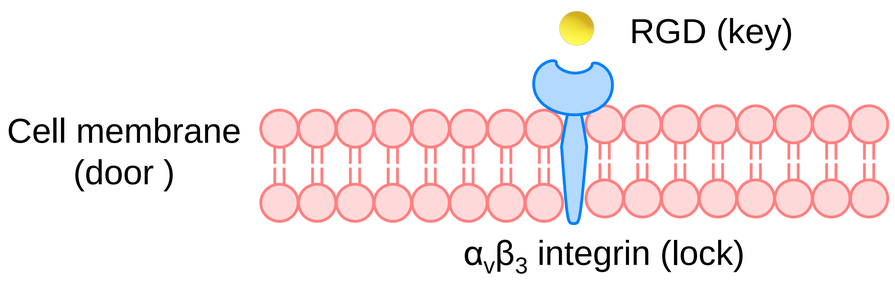
◆ Navigation to specific cancer cells （特定のがん細胞を標的にする）

- The lock and key to cancer cells　(がん細胞の錠と鍵)

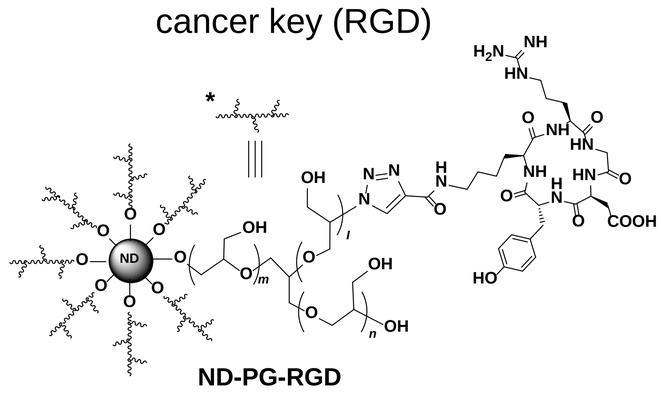
Arginine-Glycine-Aspartic acid (RGD) tripeptide motif



The specific binding between $\alpha_v\beta_3$ integrin and RGD allows particle enter cancer cell

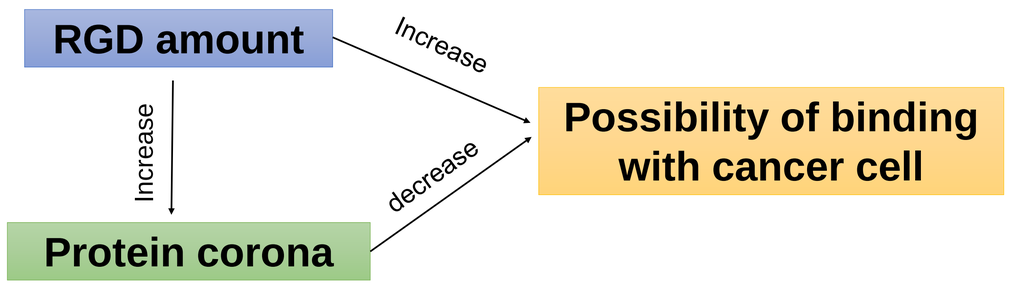


Nanodiamond is armed with invisible cloak (PG) and cancer key (RGD)

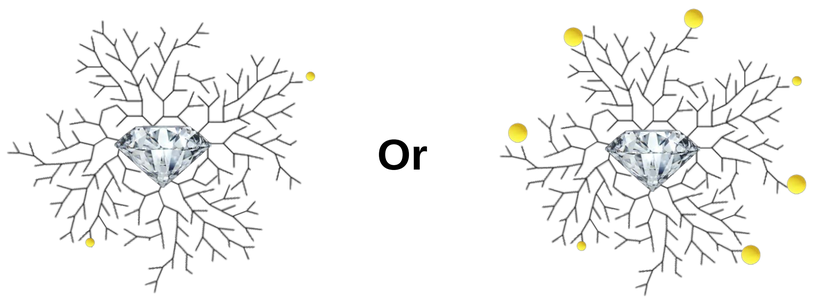


- Question: Is “less” or “more” more efficient? （質問 —— 多い方が効果的、少ない方が効果的？）

Relationships between RGD amount, protein corona, and possibility of binding with cancer cell



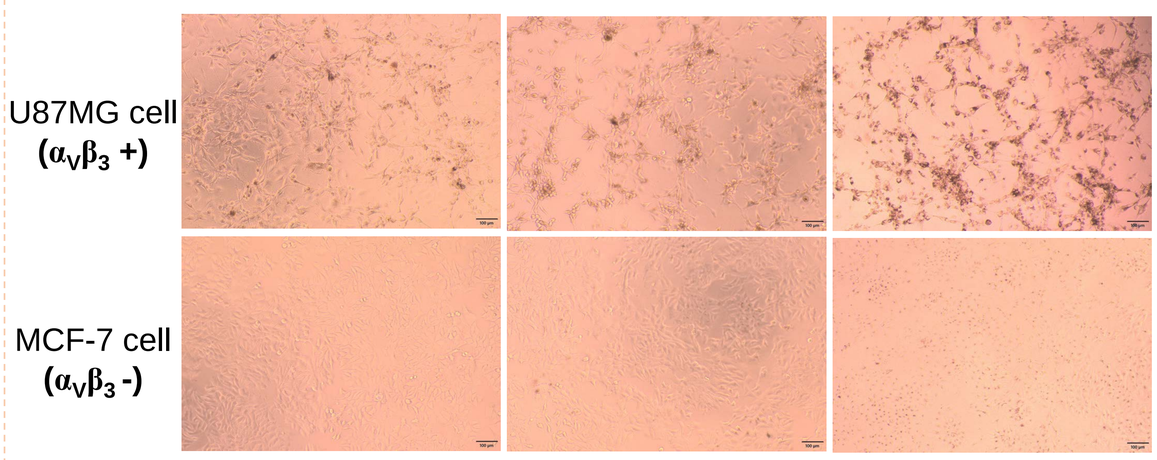
Which one would be better?



- Preliminary results --- “Less” is more efficient （予備的結果 ——少ない方が効果的)

We synthesized ND-PG-RGD with different RGD amount (-l: low, -m: medium, -h, high) and incubated with two kinds of tumor cells

Optical microscope images



Fluorescence microscope images