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Cyanobacterial Encapsulation In Biocompatible Silica Gels

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4cFuels

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Silica gels are a biohybrid material for the encapsulation of cyanobacteria.
Their internal structure is based on a highly porous three-dimensional SiO2 network with a mesoporous distribution of porosity, with a high number of micropores and mesopores. The cells are "encapsulated" in the material as they are embedded in the matrix, establishing almost direct contact with it. There is a reduced space between the cell and the silica matrix, favouring contact.

Macroscopically, the material can be presented in almost any desired shape and structure, ideally as thin films or hollow tubular monoliths of reduced thickness.
Visually, it appears to be a rigid, greenish-coloured material.
The gels allow a low diffusional limit, its transparency allows cells to photosynthesise, and it is tough.
Their synthesis is not simple, as the behaviour of the gels can be variable; but in the end they form an almost ideal encapsulation for cyanobacteria.

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- Sodium silicate 37%
- Destilled water
- KOH 0,2 M
- HCl 0,1 M
- Amberlyst resine
- EtOH
- Fresh Cyanobacterial Culture
- LUDOX® TMA colloidal silicaSigma AldrichCatalog #42085
- BG-11 Media (HEPES 10 mM pH = 8)

- Beakers
- Exchange column
- Cotton
- Micropipette
- Petri dish
- Falcon
- Flow bell
- Centrifuge

Silica precursor

1 Starting from [M]**37 % (v/v)** commercial sodium silicate, a dilution solution of [M]**5 % (v/v)** sodium silicate is prepared.

Volume of Na2SiO3 commercial x Percentage of Na2SiO3 commercial = Volume of Na2SiO3 solution x 5%

As far as possible, work in sterility, in a flow hood.

2 Cool the solution to about 4°C for at least one day in the refrigerator.

3 The ion exchange column is then prepared. For this purpose, a piece of cotton wool is placed at the bottom of the exchange column. Amberlyst resin is added on top of it until a height of about 10 cm is reached. To pack the column and allow it to exchange ions,
[M]**0.1 Molarity (M)** HCl is added.
It is then washed with distilled water to remove as many Cl ions as possible.

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A beaker is placed under the column (placed on a stand with tongs) so that the liquid passing through the column can be collected.

4 Finally, gelled the columnn as much as possible with some ice.
Then, you can start exchanging.

5 Add the sodium silicate at [M]**5 % (v/v)** to the column and wait until all the silicate has passed.

It can last a few minutes, if all goes well. But, sometimes there are some problems as a gelation inside the column. If this occur, It is only necessary to wash the column and re-add the HCl.

It is important to place a plate of ice under the beaker in which the precursor is collected; try to keep the temperature at about **5 °C** .

6 Add LUDOX with a micropipette: **15 mL** of silicate x 1,39 g/ml (density of silicate) x 0,0375 (percentage) : 1,23 g/ml (LUDOX density) **. IMP:** before add the LUDOX, the botle has been sterilized

Cyanobacteria 10m

7 Measure the OD of the cyano culture.
Then, Disinfect and sterilize all the materials that gonna be necessary.

8 30 ml of culture (OD 0,441) have been caught and then have put into a centrifuge Falcon. (2/3 of the tube)
Take an other Falcon and add water into it (30 ml) to have the same amount in both Falcon.

10m

9 **8000 rpm, 24°C, 00:10:00**
Centrifuge it

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10 Having the pellet after centrifugation, add **1 mL** of BG-11 in order to resuspend it.

Gel formation

11 With the cells, precursor and LUDOX in a Falcon, **0.2 Molarity (M)** KOH is added. The amount to be added depends on the pH. Measure with pH paper without being too intrusive with the cells. Add KOH until a pH of 8 is achieved, which is ideal for cyanobacteria.

12 Quickly deposit the mixture in a Petri dish.
Allow the gel to form.

> An alternative to accelerate gel formation is to apply heat, with caution and bearing in mind that the cells cannot withstand very high temperatures.

Gel's preservation

13 Finally, once the gel is formed, it is introduced into BG-11.

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