

# Detector basics (7/4)

Scintillator

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# Introduction

## Scintillator (Sci)

- In a few materials, the conversion of the excitation energy into light is more efficient.
- These materials which emit photons in the visible energy range or near of it.
- This phenomenon is so-called “Scintillation”.
- Light signal is very weak. So, we need signal amplification system (PMT ..etc).



Example of Scintillator (eljen)  
<https://eljentechnology.com/products/plastic-scintillators/ej-200-ej-204-ej-208-ej-212>

# Introduction

Scintillators should have following properties.

- The material should be transparent at the wavelength of the emitted scintillation light.
- The efficiency of light production should be large.
- The light pulses should be as short as possible and there should be little or no delayed light emission.
- The amount of light emitted should be proportional to the energy deposited by the ionising particle.
- The refractive index of the material should be close to 1.5 so that light can easily be extracted from Sci.



Example of Scintillator (eljen)  
<https://eljentechnology.com/products/plastic-scintillators/ej-200-ej-204-ej-208-ej-212>

# Introduction

There are 2 types of scintillator. Physics are very different.

## Organic type

- Plastic, Organic crystal, Organic liquid
- Mainly used for charged particle.

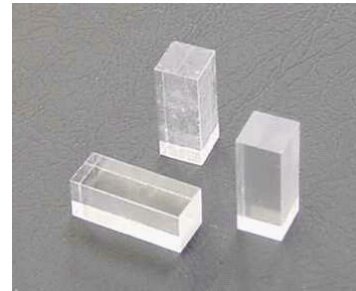


Plastic Sci

<https://eljentechnology.com/products/plastic-scintillators/ej-200-ej-204-ej-208-ej-212>

## Inorganic type

- Inorganic crystals (NaI, CsI ...etc)
- Mainly used for Gamma, X-ray.

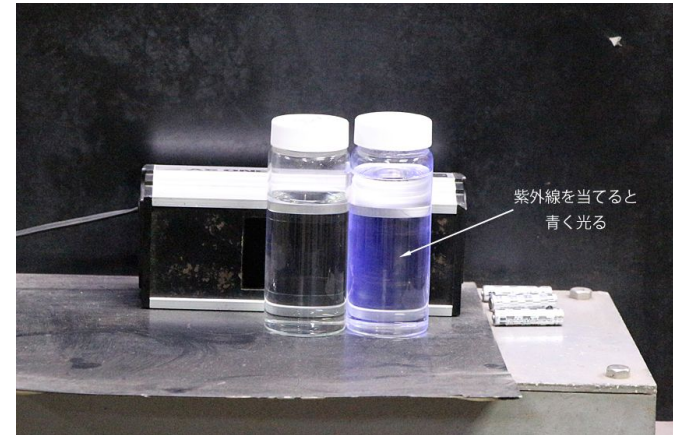


NaI Sci

<http://www.nirs.qst.go.jp/usr/medical-imaging/ja/dictionary/scintillator.html>

# Organic sci (Liquid)

- Organic Liquid sci are obtained by dissolving an organic sci in solvent.
- Wave length shifter is also added to increase the number of photons.
- Liquid type is often used for detectors which need large sci because it is cheaper than other type.
- It is also used to counting low beta activity.



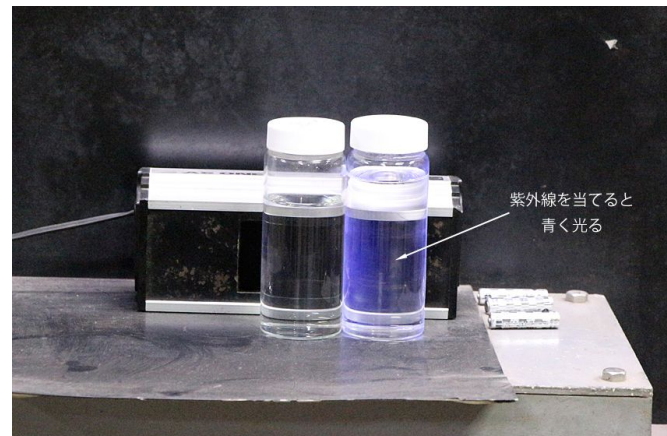
Liquid scintillator

<https://www.google.co.jp/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwjUg-G0gIPcAhWQad4KHWxQBRkQjRx6BAgBEAU&url=http%3A%2F%2Fwww.sci.tohoku.ac.jp%2Fmediaoffice%2F20161202-8797.html&psig=AOvVaw1ZJnhq1YbSVuHaC4xhZlSP&ust=1530709635410189>

# Organic sci (Liquid)

## Scintillation Principle

1. Get energy in some way.
2. Molecules of solvent are excited by the energy.
3. Expand excitation of the molecules.
4. Sci liquid is excited.
5. WLS liquid is excited. → **Scintillation !!**

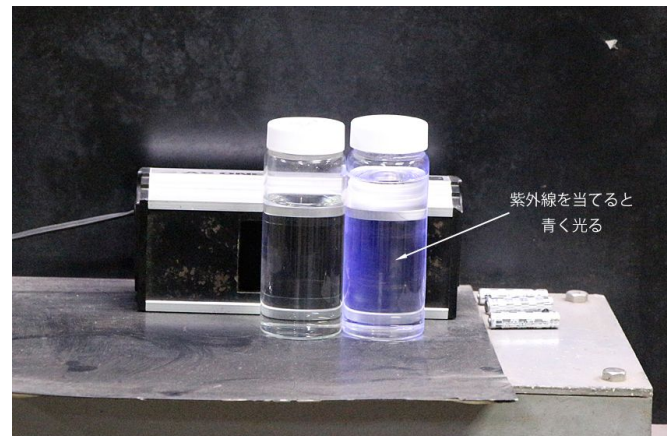


Liquid scintillator

<https://www.google.co.jp/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwjUg-G0gIPcAhWQad4KHWxQBRkQjRx6BAgBEAU&url=http%3A%2F%2Fwww.sci.tohoku.ac.jp%2Fmediaoffice%2F20161202-8797.html&psig=AOvVaw1ZJnhq1YbSVuHaC4xhZIS P&ust=1530709635410189>

# Organic sci (Liquid)

- Solvent is main part of liquid sci.
- Energy expansion is happen in 1 ns.
- It should not absorb sci light.
- Usually, they have toxicity and flammable.



Liquid scintillator

<https://www.google.co.jp/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwjUg-G0gIPcAhWQad4KHWxQBRkQjRx6BAgBEAU&url=http%3A%2F%2Fwww.sci.hoku.ac.jp%2Fmediaoffice%2F20161202-8797.html&psig=AOvVaw1ZJnhq1YbSVuHaC4xhZlSP&ust=1530709635410189>

# Presentation schedule

Today : Introduction and liquid organic scintillator

Next : Other organic scintillators

- Inorganic scintillator
- Light guide
- Photon detection (include amplification of signals from photon.)



# Reference

Experimental Techniques in Nuclear and Particle physics.

Stefaan Tavernier

シンチレータの原理と応用例 飯田崇史(筑波大)

[http://www.lowbg.org/ugnd/workshop/groupC/sn20180108/files/0901\\_lida.pdf](http://www.lowbg.org/ugnd/workshop/groupC/sn20180108/files/0901_lida.pdf)