

Long-term Overseas Dispatch (11/Sep/15~ 12/Nov/15)

Location : Ecole Nationale Supérieure Des Mines De Saint-Etienne (France)

Duration : 2015/9/12~2015/11/12

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Bio sensor array made by organic circuit

Background

The bio sensor array which is consisting of organic materials can make on flexible device. This means that the device can be conformable to human, also can be biocompatible. Recently, many research groups are digging this area for making biomedical application such as, implantable device.

However, almost organic device has a disadvantage that performance is not good as Si device. Although, some research group has already reported about flexible sensor array using Si device, since they used thick substrate (20 μm), the device was really hard to make contact between complexes surface and device [1].

In this work, we are integrating two organic circuits, one is organic electro-chemical transistor (OECT) which is higher trans-conductance than Si transistor [2] and the other one is an organic thin film transistor (OTFT) which shows highly on/off ratio [3] for making high performance matrix sensor with smaller wire numbers.

OTFT is consisted of Al gate and AlOx, self-assembly monolayer insulator and P-type organic semiconductor DNNT. Source of OTFT is directly connected to OECT. Active material of OECT is PEDOT:PSS which is P-type conductive polymer. The main reason of high trans-conductance of OECT is a porous structure of PEDOT: PSS which makes huge capacitor between target and OECT. Until now, we were trying to solve unbalance between OTFT and OECT for integrating.

One is resistance unbalance. OECT usually showed high conductivity when it is a normal state. However, OTFT showed poor resistance when it is on the state because of low mobility. Also, for highly concentrated bio sensor, OTFT need to make at small area. Although, we solved this problem with making the short channel length of OTFT, process method was complicated.

Second was temperature unbalance. PEDOT:PSS of OECT needs to anneal for cross linking. GOPS was added at PEDOT:PSS base solution for cross linking, and it needs to be annealed at 150 degrees 30 minutes after deposition. However, OTFT starts degrading mobility at 60 degrees annealing. We solved this problem with the long term annealing process at 55 degrees, but we didn't investigate OECT performance with new recipe.

[1] J Viventi et al, Nature Neuroscience 14, 1599-1605 (2011).

[2] D Khodagholy et al, Nature Communications 4, 1575 (2013).

[3] M Kaltenbrunner et al, Nature 499, 459-463 (2013).

Purpose for visitation

At first, the reason why I decided this university is to visit George Malliaras Lab which is first laboratory to develop bio measurement system using OECT. Besides, George Malliaras Lab have researched on bio measurement system using other flexible device. So I hoped to learn such kind of bio measurement technique using flexible device.

Before I decided to visit Malliaras Lab, I contacted professor and discussed about what we can do at their Lab. I told them about OTFT yield problem. Luckily, they have solution to solve this problem with special photoresist which is very gentle for organic materials. So, we decided that the special photoresist is also tried on my device when I visit.

Also, as a researcher who researched on OECT, I want to see what they are recently doing with OECT.

Local Life

I thought that most important thing is where I stay during visitation. Considering this program term should be over 2 months, accommodation fee will be most expensive. Also, I needed to find most close house from school. Most good way was school dormitory. However, unfortunately 2 months is too long for getting dormitory, so I needed to find other accommodation.

Airbnb is most good way to find house. You can find good houses cheaper than hotel. Also, you can meet hosts of your house, and they are usually very kinds. In case of this time, my host introduced local place in France. Also, you can get tip for living their local society such as how to deal with trash.

When I was in France, most hard thing was food. French bread, meat is great when I ate first time. But I couldn't eat every day French foods. My asian friend at that school gave me tip for finding Asian foods. So I just find china super market. China super market is located in every Europe. And they are usually selling not only china foods but also every Asian foods.

In school life, I thought that most different thing with Japanese laboratory is friendship between students and professor. Their students always communicate with professor as a friend. Even they called professor as first name. This is impossible at Asian laboratory not only Japan. Thus, they decided very quickly about experimental device problem or publication etc.

Finally, before visiting laboratory in abroad, it is better to know simple local language. In France, they are really like to speak French. When I said greeting and introducing my self with French, they really liked that. It is good way to get close local people like secretary. (They are very important, because we need to fill any document when we visit there. If you are not closed with them, it takes long time when you want to get simple ID card.)

Acknowledgement

This visitation was entirely supported from Takao Someya group. The writer is financially supported by MERIT (Materials Education program for future leaders in Research, Industry, and Technology) during this dispatch term.