Challenge for Blue Organic Light Emitting Diode

2nd Oct. 2020

Hyoung Yun Oh. CEO/Ph.D
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Motivation

A Small Story about the Ceiling
A long time ago,

*The Ceiling* was the place where we draw the things we see & think!
Motivation

A Small Story about the Ceiling

After discovery of the lamp, we are handed over the space to the light because it was too bright to put elsewhere!

Instead, we got a new lifestyle, Which is more freedom and social life at night!
Motivation
A Small Story about the Ceiling

Whenever we see the ceiling, the brightness of lamps made us turn our head elsewhere

For more than one century The Ceiling has been uncharted territory. Can’t we get this valuable space back?
Motivation
A Small Story about the Ceiling

If the intensity of those lights could go lower by wallpaper lighting, we have more options in our lives.

Our creativity will begin to work again. Just like our ancestors did!
Motivation  A Small Story about the Ceiling

We can show lifelikeness Michelangelo’s painting to children in their rooms up on the space, who would dream of becoming artists.

In school, we can show the universe to students as real-time image from satellites for their sensual experience to be expanded.
Motivation

A Small Story about the Ceiling

The tunnels will turn out to be a short track of museum seeing different views

In the hospital, the ceiling would become a good friend to a patient
Motivation

A Small Story about the Ceiling

Also, we can give a little fresh mood by providing lifelikeness images of sunsets, stars and beauty of natures.

Enjoy Sunset

Sleep with Stars

Wake up to Sunrise

This could be great elevating ways of life condition for post COVID-19 era we are facing.
The Era of OLED is Coming!

<table>
<thead>
<tr>
<th>New Technology</th>
<th>19C</th>
<th>20C</th>
<th>21C</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Finding</td>
<td>1802~</td>
<td>1907~</td>
<td>1950~</td>
</tr>
<tr>
<td>Prototype</td>
<td>1840~</td>
<td>1962~</td>
<td>1987~</td>
</tr>
</tbody>
</table>

Platinum Filament  
Red LED  
Alq₃ Green Light  
Bamboo Filament  
GaN Growth Process  
Blue OLED  

Market  
1878  
1992  
2020~?

Thus, as historical track tells us,  
I believe,  
The blue problem will be solved soon in near future.
so for OLED, The panel company completes the technology. Because Blue has not been developed fully yet, the panel company still has to work intimately with the chemical company. Thus, closer cooperation between chemical and panel companies is needed ever than before.
# Company Introduction

- **Business**: Currently, OLED Blue Materials

- **Foundation**: 1<sup>st</sup> February, 2020

- **Head Quarter**: Dongtan, Korea

- **Finance**: $200,000 Korea Technology Finance Corporation
  
  $200,000 Korea SMEs and Startups Agency
  
  $2 million in Series A financing ongoing

- **Members**: 8

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Background</th>
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</table>
| CEO/Ph.D            | Hyoung Yun Oh | OLED 1997~Current Materials Devices  
                       |                             | JV Experience In China (LGE, LGD)                                             |
| CTO                 | Okhee Kim    | OLED 1996~Current OLED Panel Devices  
                       |                             | JV Experience In China (LGE, LGD)                                             |
                       |                             | JV Experience In China (Shinwha Intertek)                                     |
| Adviser/Ph.D       | Yoonki Choi  | Total Synthesis 1993~Current Medicine Cosmetic Dye sensitizer Film/Coating (PIGEON, ILJIN) |
We started doing this when OLED first started in Korea.

So we decided to set up a company where we can develop blue.
Our Business Strategy ABC

A
Patent Analysis
- Newly Opened Patent 500~700 monthly
- Expired Patent ~100 monthly
- Material Ownership Analysis
- Alliance with IP Law Firm
- Patent Business
- Valuation, Licensing, Purchase

B
License Contract
- Conditional Licensed Patent 38
- Materials for Hole & Electron Transport
- Products
- Alliance with Material Company
- Sales to Panel Company
- Super Blue Study
- Alliance with Device Company

C
Niche Market Search
Joint Venture
Wallpaper Lighting

Company Introduction

15/30

About 700 new patents are released every month.
At least more than 30 material companies are consistently writing patents.
The structure you are creating now may already be under way by someone else

Also, more than 100 patents are expiring every month.
Through these patents, you may find available materials.

We are working with IP law firm and a market research company to create this product.

<table>
<thead>
<tr>
<th>Nation [Code]</th>
<th>Nation [Applicant]</th>
<th>Applicant</th>
<th>Purpose</th>
<th>Application</th>
<th>Chemical Formula</th>
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<tbody>
<tr>
<td>KR</td>
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<td>A Company</td>
<td>EML</td>
<td>Soluble</td>
<td><img src="image1" alt="Chemical Formula" /></td>
<td><img src="image2" alt="Chemical Formula" /></td>
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</table>

<table>
<thead>
<tr>
<th>Legal Status (KR, JP, EP, CN)</th>
<th>Application No.</th>
<th>Publication Date</th>
<th>Registration Date</th>
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<tbody>
<tr>
<td>Registered</td>
<td>10-xxxx-xxxxxx</td>
<td>2020.01.01</td>
<td>2020.01.01</td>
</tr>
</tbody>
</table>

Available for purchase

A minimum of two weeks is required to review all the patents

By using this report, you can effectively check the information within about an hour.
Our First Product

Monthly Patent Analysis report

Number of Patents by specific applicants on April

Chemical Structures Major three companies made on April!

- **GH**: Triazine-2 Ar,
  - **Te-Heteroaryl**,
  - **Te-C6**,
  - **Te-Dithiane diamine**,

- **BH + BD**
  - **An & Barrene**
  - **An & Ts**

- **BH + HBL**
  - **An & Ts**

- **BH + ETL**
  - **HBL+ETL**

- **BH + HTL**
  - **An & Triazineamine**

*Te = Triazine
*Co = Carbazole

**Notes:**
- Chemical structures for major companies' patents on April are depicted with detailed molecular structures, indicating the specific compounds patented by each company.
- The patent analysis is comprehensive, covering patents filed in various countries, including the United States (US), South Korea (KR), and China (CN).
- The patent numbers and filing dates are provided for each chemical structure, allowing for detailed examination of the intellectual property landscape in the field of triazine chemistry.
Our First Product

Number of Patents by nation of applicants in 2020

Number of Patents by OLED application in 2020

Monthly Patent Analysis report
When a new bone of organic material is developed, it becomes a patent.

Interestingly, for common layers, although many patents are being made, it's hard to expect noticeable changes in performance.

Because the basic concept for them have not been changed for more than 30 years
LORDIN’s 1st Plan for Blue OLED

New Material

Device Company

Device Design
Device Analysis

Material

Synthesis
Patent Search

Band Gap Energy Control
HOMO & LUMO Energy Level Control

Patentable? Expired Patent?

Concept
Calculation/AI

SO-Coupling/ Triplet State

Device

Analysis
Device

JVL/Lifetime/ Impedance/ ESR

Accuracy Reproducibility

Motivation

By Understanding the Molecule

Synthetic Method

Find Synthetic Method

Material

Total Labor Investment Research

Device

Million Dollar/year

R&D Cost for 1st 1year

0 1 2 3 4 5

Million Dollar

0 1 2 3 4 5

Business Strategy B
LORDIN’s 2nd Plan for Blue OLED Manufacturing Process

1st New Material
2nd Manufacturing Process Development

SO-Coupling (Metal/TADF)
IQE > 90%

PL 450~465nm
FWHM <28nm
Multiple Resonance

Efficiency
Color
Lifetime

The remained task for the blue is the lifetime, which cannot be merely resolved by making a new material.

Contamination caused during the manufacturing process affect the lifetime.
One day, In the OLED production line, Big problem happened! The lifetime of OLED products drastically shortened.

Finally, we found out that the entire chamber was contaminated from the mask stock chamber where the mask is contaminated during cleaning process!
So, We did gas effect on organic layers

Exposure of OLED Film to O2
Business Strategy B

LORDIN’s 2nd Plan for Blue OLED

Manufacturing Process

The place with the highest exiton’s density was affected the most.
The luminous lifetime of the device increases when the device is manufactured continuously without breaking the vacuum.

Problem in Material? or Vacuum?
LORDIN's 2nd Plan for Blue OLED  
Manufacturing Process

Break Vacuum and take it out
Expose \( \text{N}_2 \) to \( \text{N}_2 \) for 30min

Break Vacuum and take it out
Expose \( \text{Air} \) to \( \text{Air} \) for 30min

Break Vacuum and take it out
Expose \( \text{N}_2 \) to \( \text{Air} \) for 30min

Vacuum

Vacuum

Vacuum

Vacuum

We must be very careful to handle the organic molecules.
LORDIN’s 2nd Plan for Blue OLED

Manufacturing Process

From Synthesis To Device Fabrication

After synthesis, organic molecules are exposed pretty much amount of time in the air and room light

<table>
<thead>
<tr>
<th>Synthesis</th>
<th>Purification</th>
<th>Device</th>
</tr>
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<tbody>
<tr>
<td>1 ~2 days</td>
<td>7~10 days</td>
<td>2 days</td>
</tr>
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</table>

Chemical Reaction
- Precipitation
- Silica Gel Column
- Recrystallization
- Filter/Drying

Inert Condition

Sublimation
- Vacuum

Loading
- Under Air & Room Light

Collecting
- Under Air & Room Light

Evaporation
- Vacuum Quality?

We are in need of detailed research related to manufacturing process.
1. No serious effect on performance by exposing some organic layer to Air

2. Polymer based foldable display is commercialized

3. NEW BLUE MATERIALS

4. MANUFACTURING PROCESS

We will cut and put the lightings on the wall, everywhere, anywhere you want as a paper.
Summary

1. Historically, new technologies required 30-40 years of technology accumulation time from prototypes to products. It's been about 34 years since OLED was reported.

2. Thus, as historical track tells us, the blue problem will be solved soon in near future.

3. We need more understanding of the triplet states in molecules.
   The deeper we understand molecules, the more willing we are to find new synthetic way!

4. We need more understanding of the contamination in the manufacturing process.
   The deeper we understand it, the more accurate the material evaluation will be.

5. LORDIN is trying to clearly understand the molecules and the fabrication process based on more than 20 years experiences in panel and material company.

6. Surely, the products from OLED will give us very new life style in near future!
Thank You!

LORDIN COPYRIGHT