An in-depth analysis of patent thickets:

A case study of lithium ion accumulators

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Patent thicket definitions:

- “A dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize a new technology” (Shapiro, 2001)

- “Numerous patents that protect components of a modular and complex technology” (Hall, 2012)

→ Situation where a firm needs to use many complementary patents owned by other firms in order to produce its own product
Recently, there has been a widespread and growing concern about the patent thicket and its impacts (Ex. Shapiro, 2001; von Graevenitz et al., 2011, Fischer and Ringler, 2015)

Intrinsically links to phenomena of **patent surge**, **patent wars** and **patent quality**

The patent thicket changes patenting behavior of many firms

⇒ *Patent thicket* maintains its own growth

Concerns & problems:

- **Barriers to entry**: *Patent Thickets* obstruct entry to some markets (ex. Hall, 2012)
- **Barriers to innovation**: *Patent Thickets* impede innovation (ex. Ian Hargreaves, 2011)
- **Failure property rights/ patent system** (ex. Bessen and Meurer, 2008) : “if rights are so highly fragmented that the costs of negotiating the rights needed to make an investment become prohibitive”. Substantial bargaining costs
Methodology for patent thicket identification

Methodology developed by von Graevenitz et al., 2011 based on the fragmentation of ownership between applicants

- Builds on patent citation:
  - **X and Y references, called critical references**
    - Critical references – also known as X and Y citations – point to prior art that jeopardizes the novelty or inventive step of the claimed invention
    - Useful for identification of blocking relation

- **Patent thickets evaluated at applicant level**
  - **Detection of TRIPLES** = a group of three firms in which each firm has critical prior art limiting claims on recent patent applications of each of the other two firms
    - Useful for identification of mutual blocking relations
Analyzing the patent thickets & methodologies of construction

Figure 1: Illustration of the structure of unilateral, bilateral and multilateral blocking relationships between patent holders

- **Existing structure**
  - ----> unilateral reference
  - ——> bilateral reference

- **Identified structure**
  - —— mutual blocking relation
Technology study: Lithium Ion battery

- **Complex Technologies**
  
  Figure 2: Value chain of lithium ion accumulators in the car industry

  Different competences used: electrochemistry, material sciences, electrical engineering, electronics and software development

- **Applications for several industries**
  
  Mainly car industry, electric transportation, consumer electronics

- **A technology in an era of technological emergence (ex. Car)**
  
  Change, experimentation and uncertainty
  
  In the large family of Li-ion technology, different solutions compete
**Construction of the patent portfolio**

Use of the **Questel patent database**: - international database  
- patents grouped by family

Combination of **patent technical classes** (ICP Classes) and **key words**

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<tr>
<th>TEMPORAL RESTRICTION</th>
<th>TECHNICAL RESTRICTION</th>
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= 38399 patent families
PART 1 -

Static analysis of the Patent thicket:
Li-Ion Patent thickets from 2000-2013
Li-Ion Patent thickets from 2000-2013
### Methodology

Limited

Chinese patents and all others patents from offices which don’t use X, Y citations are not covered

<table>
<thead>
<tr>
<th>MAIN APPLICANTS</th>
<th>TOTAL PATENT</th>
<th>NUMBER OF PATENTS CITED in X and Y CAT.</th>
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Triple (3 applicants) and more?

Patent thicket = 3 actors mutually blocking. But, what happens if the criteria is increased: i.e. 3 and more actors concerned?

In the portfolio, we identified networks with 7 fully interconnected applicants.

*Patent-thicket*

With **triple**: 3 applicants concerned
150 applicants (70% total)

*Patent-thicket*

With **5 applicants** concerned
44 applicants (23% total)

*Patent-thicket*

With **7 applicants** concerned (max)
18 applicants (10% total)
Patent thicket core

Main applicants integrated in the more dense patent ticket:

**Battery material specialist:**
- Mitsui

**Battery specialists (modules and components):**
- Hitachi (mainly for car industry)
- Panasonic (mainly for car industry, consumer electronics)
- Sanyo (mainly for car industry, consumer electronics)
- Gs Yuasa
- Samsung (mainly for car industry, consumer electronics)
- Toshiba (mainly for car industry, consumer electronics)
- Sony (mainly for consumer electronics)
- Mitsubishi (mainly for car industry, consumer electronics)
- Lg Chem (mainly for car industry, consumer electronics, power grid)
- NEC (mainly for car industry)
- Sumitomo

**Application domain specialist:**
- Toyota
- Nissan

*Only two carmakers integrated in the core of the patent thicket. Confirm the focus of these two carmakers in storage energy technologies*
Main applicants integrated in the more dense patent ticket:
Hitachi, Panasonic, Sanyo, Mitsubishi, Sony, GS Yuasa, Toshiba, Nissan Motor, NEC, Mitsui, Samsung, Toyota, LG Chem & Sumitomo
In bilateral relationships: **strong asymmetries between citing / cited applicant**

For instance, « *Asymmetric/unilateral dependence* »

« *Bilateral/mutual dependence* »
PART - 2 -

Dynamic analysis of the patent thickets:
5 year window analysis from 2000-2013
Resultat 1- Analysis of the position of actors in the thickets over time.

Li-Ion Patent thickets from 2000-2004

Nodes = 31
Links = 37
Density = 0.209
Modularity = 0.707
Clustering coefficient = 0.67
Main applicants (number of triples) =
- Panasonic
- Sony
- Mitsubishi

Thicket with 5 applicants
10 applicants concerned : Hitachi, Panasonic, Sanyo, Mitsubishi, Sony, GS Yuasa, Toshiba, Japan Storage Energy, NEC, Mitsui

New applicant
Applicant out

Li-Ion Patent thickets from 2004-2009

Nodes = 51
Links = 152
Density = 0.119
Modularity = 0.527
Clustering coefficient = 0.413
Main applicants (number of triples) =
- Panasonic
- GS Yuasa
- LG Chem and Toyota

Thicket with 5 applicants
14 applicants concerned: Hitachi, Panasonic, Sanyo, Mitsubishi, Sony, GS Yuasa, Toshiba, Japan Storage Energy, NEC, Samsung, LG Chem, TDK, Toyota, Mitsui

New applicant
Applicant out

Li-Ion Patent thickets from 2010-2014

Nodes = 45
Links = 156
Density = 0.158
Modularity = 0.462
Clustering coefficient = 0.67
Main applicants (number of triples) =
- Panasonic
- Toyota
- Mitsubishi

Thicket with 6 applicants
15 applicants concerned: Hitachi, Panasonic, Sanyo, Mitsubishi, Sony, GS Yuasa, Toshiba, Japan Storage Energy, NEC, Samsung, LG Chem, TDK, Toyota, Mitsui, Nissan Motor, Sumitomo, 3M, Showa Denko

New applicant
Applicant out
Indicator dynamics (1): Number of triangles & number of links

Triangle number per actor from 2000 to 2013

Number of links per actor from 2000 to 2013

2 actors have the same dynamic when it comes to thicket created along the period

<table>
<thead>
<tr>
<th>Actor</th>
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<th>T3</th>
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<td>MITSUBISHI</td>
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Evolution of links

Important Increase
Toyota, Samsung, Sumitomo, LG Chem

Increase
Sanyo, Sony, NEC, Hitachi

Stabilisation
Panasonic, Mitsubishi
Indicator dynamics (2): clustering

Evolution of the clustering coefficient from 2000 to 2013

Evolution of clustering

Increase: Mitsubishi

Stable: Panasonic, Hitachi, Sony, LG Chem, Sanyo

Decrease: NEC, Sumitomo

Important decrease: Toyota, Samsung,
Perspectives

Three main ways of improvement:

- Take into account the **weight of bilateral relationship**
  
  Important asymmetries if relationships are observed on a case-by-case basis. Methodological challenges for it to be taken into account in the whole data portfolio.

  *aim: To attain a better measure and assessment of the global patent thicket*

- Take into account **precisely the technologies concerned**
  
  Applicants must be positioned on several technological elements (for instance in our case study: components, BMS, material, ...)

  *aim: Go further into detail on trilateral blocking relationships in order to see if the competition covers exactly complementary or substitutable technologies*
For the moment, all patents have been considered. A choice in favor of a full perception of competition about lithium-ion batteries.

Next step, study the **patent status** (Patent granted: yes/no? Patent renewed: if yes, how long?)

*aim: determine if applicants keep alive strategic, blocking patent or not (underestimation of the power of patents).*
Any Questions?
Thank you for your attention

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