

## EMERGING COMPETITORS IN EMERGING MARKETS: WHAT PATENT APPLICATIONS REVEAL

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### ABSTRACT

Strategic business decisions begin with assessments of market need, value proposition and differentiation, profit potential and sustainability. Predicting the future implies uncertainty and emerging markets often push forecasting into the realm of guesses and hunches. However, structured analysis of published patents and patent applications provides valuable insight into strategies, aspirations and expected competitive positions long before the first sale in an emerging market.

Using MEMS packaging as an example, the authors show how in emerging markets pending patent applications often outnumber issued patents and then demonstrate how careful study of public databases for published patent applications yield a detailed picture of anticipated competitive environments as well as quantification of market trends and growth expectations. Finally, the authors apply the IP landscaping method to developing a strategic framework useful for investment, market development and strategic alliance planning.

Key words: intellectual property, patents, patent applications, MEMS packaging, emerging markets, competitive environment.

### INTRODUCTION

Business planning requires judgments regarding market need, value proposition and differentiation, and profit potential and sustainability. Forecasting (predicting the future) either extends existing trends or seeks out similar situations and assumes history will repeat itself. However, markets for emerging technologies generally offer no reliable track record to extend. Emerging markets may match the patterns of other developments but scarce data for choosing one historical situation over another forces decision maker to rely on guesses and hunches – a risky and uncomfortable approach.

International patent law creates a window into strategies, aspirations and expected competitive positions long before the first sale in an emerging market. Because sale or other disclosures limit patent rights, hopeful competitors file patent applications as early as possible. After a statutory waiting period, the patent offices publish once-secret patent applications. In addition, issued patents immediately become part of the public record.

A systematic analysis of pending patent applications and issued patents offers a detailed intellectual property (IP) landscape useful for investment, market development and strategic alliance planning.

### IP ANALYSIS METHODOLOGY

Key questions addressed in analyzing an (IP) landscape include: Who filed the patents? What areas of technology coverage past the scrutiny of the examiner? When and where did filing of the patents take place? Do coverage or technology gaps exist? What opportunities remain unexploited?

The methodology developed by the authors consists of the following steps:

1. Develop a comprehensive database of patents and patent applications by searching available on-line databases by patent classification, keyword and key inventors and assignees.
2. Assess the individual relevance of each patent and patent application using recursive and quantitative algorithm based on US and international classifications, keyword matches and proximity, relevance of other patents and applications with the same inventors and assignees, and the relevance of references and citations.
3. Follow reference and citation trails for each patent and patent application to identify additional significant patents, applications, inventors and assignees. The authors define references as mentions of older patents within the text of a particular patent. Required by law, references highlight related prior art. Both the inventors and examiners may add references to a patent. In contrast, the authors define citations as mentions of a particular patent in other, subsequent patents.
4. Classify or sort each patent and patent application by key subject matter. Review claims and group by key idea or type.
5. Assign a relative value to each patent and patent application by counting and characterizing all citations to each patent. Several authors<sup>1,2,3</sup> demonstrate the correlation between citations and patent value.
6. Identify competitive participants and analyze their strategies as reflected in their patent filings. Aspects of revealed strategies include long term investment, short

term exploitation, technical strengths, and capability gaps.

7. Identify opportunities by assessing subject matter, geographic, and/or assignee trends. Also, weaknesses and gaps in the portfolios of weaker participants may create the potential for strategic relationships.
8. Define strategic options based on the existing IP landscape. All participants seek cost and/or performance advantages, sustainable barriers to competitors, and freedom to operate (avoid infringement). Strategic options include patent filings, licensing, acquisitions, and various forms of strategic relationships.

### **PATENTS AND PATENT APPLICATIONS**

Patents represent a set of exclusive rights granted by a government to an inventor or their assignee for a limited period of time in exchange for a public disclosure of an invention. Like a property title, patents contain an explicit definition of the invention (claims). Patents conform to a rigid format. Patents enjoy the assumption of validity. Although intangible, patents are unambiguous.

The process of obtaining a patent begins with filing a patent application. Next, the application undergoes examination during which the government verifies compliance with the statutory requirements of a patent. During the examination process, the government and inventors often negotiate the breadth and specific language of the claims which define the invention. Ultimately, the revised patent is denied or allowed (issued).

On average, 40 months elapses between filing of the application and patent issue or denial. Moreover, substantial revisions frequently occur between filing of the application and patent issue.

As a result, a pending patent application contains important uncertainties compared to an issued patent. Specifically:

1. The application may never become a patent. If rejected, a patent application becomes prior art without any exclusive rights for the inventors or their assignees. (Common.)
2. A patent may issue with claims identical to those contained in the application. (Very rare.)
3. A patent may issue with similar but narrower claims than contained in the application. (Very common.)
4. A patent may issue with claims revised so heavily as to be unrecognizable from the application. (Rare.)
5. The length of time between filing and patent issue or denial varies greatly from a few months (very rare) to many years (not unusual). Markets often move much more quickly than the patent examination process.
6. Patent applications do not conform to any standard format. Some applications contain complete and detailed

information while some simply outline key concepts. For example, patents normally indicate assignees and references but applications often have neither.

7. If filed in multiple countries, an application may result in widely differing (or no) patents in each country.
8. Patent applications generally have few, if any, citations. As a result, the valuation methodologies cited previously do not apply to applications.

Finally, patent applications entail little expense compared to issued patents. Smaller entities may elect to abandon patents rather than pay the associated fees after considering market conditions and cash flow.

In the case of new and emerging technologies, the possibility of patent application rejection (denial), the length of the examination process, and the low relative cost of patent applications often result in pending patent applications significantly outnumbering issued patents.

Thus, in spite of the associated uncertainties, pending patent applications often dominate the IP landscape for emerging markets. Far from an impediment, patent applications reveal the world as the applicant sees it, rather than as the patent office sees the world. Patent applications reveal the aspirations and expectations of competitors in ways patents cannot.

### **CASE STUDY: MEMS PACKAGING**

While MEMS market reports and technology surveys are available, no systematic, industry-wide reviews of the MEMS packaging intellectual property landscape exist. This paper reports a preliminary analysis of 2,877 US patents and patent applications related to MEMS packaging. Ongoing analysis of the World IP Organization (WIPO) and European Patent Office filings targets a global understanding of the MEMS packaging IP landscape with expected completion in mid 2010.

MEMS packaging currently enjoys considerable attention as represented by industry publications<sup>4,5,6</sup>, conferences<sup>7,8,9</sup>, industry groups<sup>10</sup> and patent filings. Typical of emerging markets, 1,673 pending US patent applications related to MEMS packaging outnumber granted 1,204 US MEMS packaging patents.

While sharing many requirements with conventional semiconductor packaging, MEMS packaging differs in several key attributes. The most fundamental distinction is the need for non-electrical feed-throughs permitting interaction with the environment. The fragile, often movable microstructures cannot be encapsulated with molding compound and often require cavities within the package. Finally, MEMS structures typically require extra protection during assembly operations.

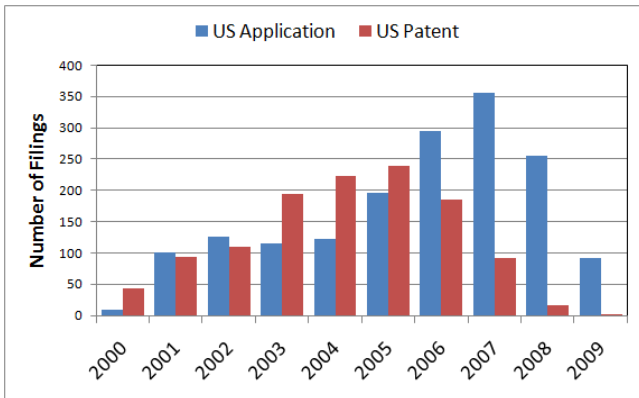
A number of enabling technologies, including low-damage wafer dicing, wafer bonding techniques, sealing

technologies, wafer-level packaging and through-silicon vias, form the basis for much of the competitive differentiation among industry participants.

The combination of unique requirements of MEMS packaging and availability of multiple technical approaches create a rich intellectual property landscape.

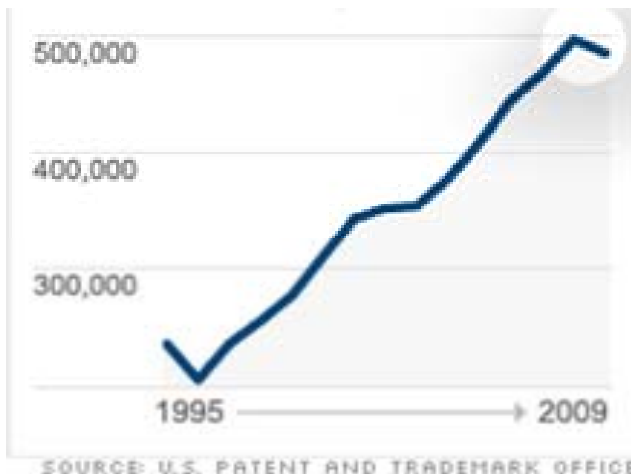
**FILING DATE ANALYSIS**

Figure.1 shows the number of US patents and patent application in the MEMS packaging arena by filing year from 2000 through 2009. As expected, the number of granted patents falls off sharply after 2005 reflecting the average patent examination period of 40 months.



**Figure 1.** # of MEMS packaging patents & applications vs. filing year

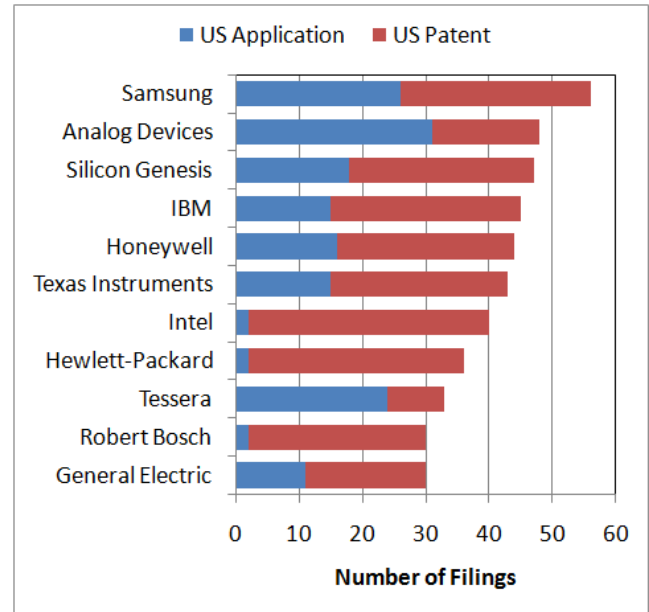
The 18 month delay in publishing US patent applications may account for the fall off in patent applications in 2008 and 2009. However, the recession of 2008-2009 likely also contributes to the decrease in filings shown. CNN cites US Patent and Trademark statistics showing the number of US patent filings fell 2.3% in 2009 marking the first decline in filings since 1996 and attributes the decline to the recession<sup>11</sup> (Figure 2).



**Figure 2.** US Patent filings decline in 2009 due to recession<sup>11</sup>

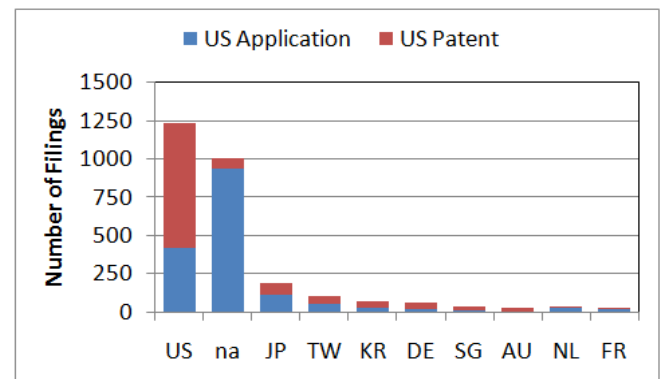
**ASSIGNEE ANALYSIS**

Figure 3 shows the ten largest MEMS packaging portfolios (patents plus applications). Figure 3 shows MEMS packaging IP ownership dominated by large vertically integrated and research driven corporations with the notable exceptions of Silicon Genesis and Tessera, both IP companies. High-profile start-ups in the MEMS area, while present, generally hold relatively few patents and patent application assignments.



**Figure 3.** Ten largest MEMS packaging portfolios

Figure 4 shows the geographic distribution of MEMS patents and patent applications. The second bar label “na” refers to filings without assignment indicated in the filing. In the case of patents, “na” usually refers to cases in which the inventor is an individual that does not assign the patent to an employer. On the other hand, patent applications frequently bear no assignee information as noted above.



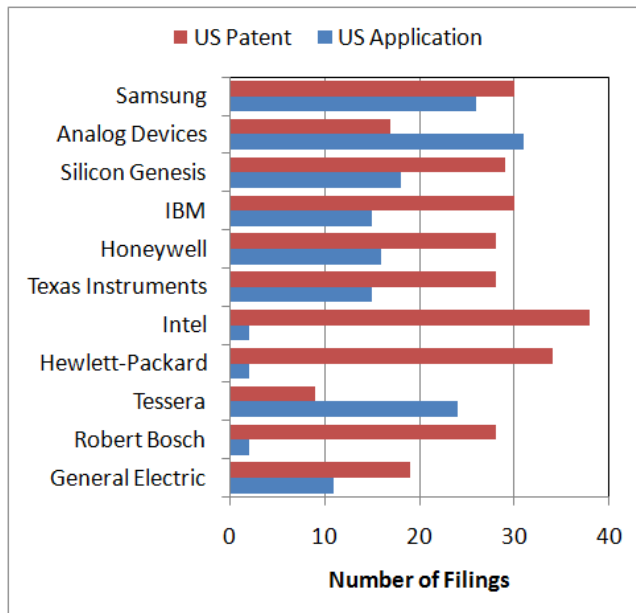
**Figure 4.** Geographic distribution of MEMS packaging patents and applications

Figure 4 clearly indicates a US lead, even vis-à-vis Japan, in MEMS packaging assignments. Arguably, the reliance on the US patents and patent applications biases these findings

toward US assignees. However, previous IP landscape studies by the authors<sup>12,13,14</sup> demonstrate the minimal impact of such bias as the vast majority of patent applicants worldwide quickly file corresponding US patents to ensure protection in the largest markets in the western world. Overall, an analysis of US filings represents a valid and reasonable indicator of the world-wide IP landscape.

### COMPETITOR STRATEGY ANALYSIS

Given the uncertainties associated with patent applications, treating patents and patent applications separately provides additional insight to the competitive positions (and strategic aspirations) of the leading participants. Figure 5 replots the data of Figure 3.



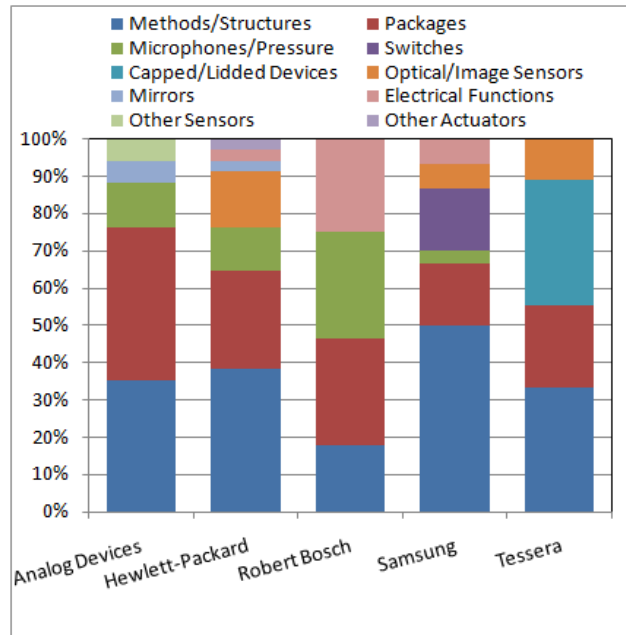
**Figure 5.** Ten largest MEMS packaging portfolios with patents & patent applications separated

Immediately, we note that some portfolios consist of mostly granted patents with relatively few pending applications (Hewlett-Packard, Bosch); some consist of mostly pending applications (Tessera, Analog Devices); and others have a nearly even mix of patents and pending applications (Samsung).

Analysis of the targeted market application of each patent and patent application in these portfolios reveals even more about strategies. For example, Figure 6 shows the distribution of targeted technologies/applications in the portfolios of the several leading participants. Identified targeted market applications include:

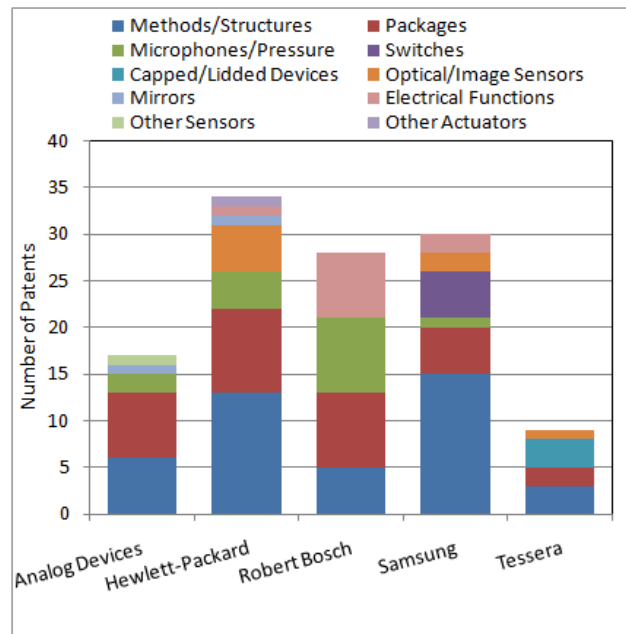
- Packages for MEMS devices
- Microphones and MEMS Pressure Sensors
- MEMS Switches
- Capped and Lidded Devices
- Optical MEMS and Sensors
- MEMS Mirrors

- MEMS Devices with particular electrical functionality (oscillators, resonators, etc)
- Other Methods & Structures
- Other Sensors and
- Other Actuators



**Figure 6.** Distribution of market applications targeted in leading MEMS packaging portfolios (patents plus pending applications)

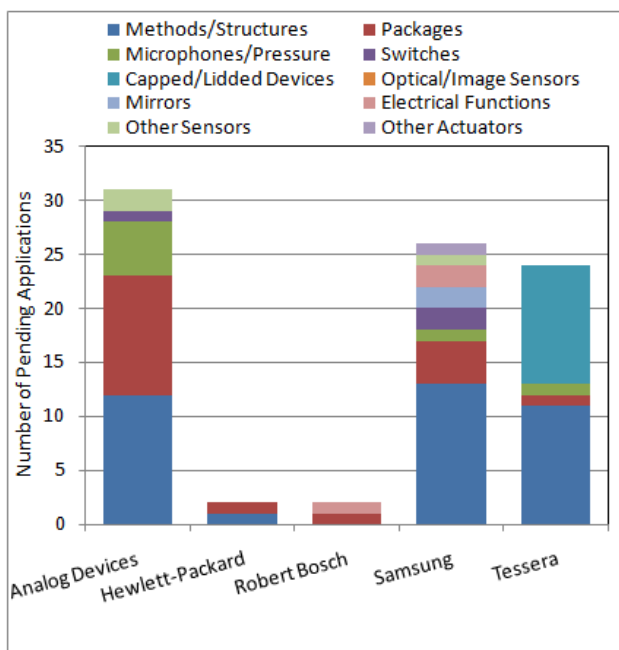
In Figure 6 one observes a strong emphasis in resonators and oscillators by Bosch while Tessera focuses on IP for capped or lidded devices. HP and Samsung show widely distributed efforts for differing target market applications.



**Figure 7.** Distribution of market applications targeted in leading MEMS packaging portfolios (patents only)

Figure 7 refines the target market application analysis with a patents only view. The distributions of IP for HP, Bosch and Samsung change little from Figure 6 which reflects patents and pending applications because for these firms either issued patents dominate their portfolio or the focus remains equally balanced between patents and applications.

Figure 8 shows the distribution of market applications targeted in pending patent applications for the same set of portfolios, the complementary picture to Figure 7. HP and Bosch show little activity in pending MEMS packaging patent applications compared to Analog, Samsung and Tessera. Also observe the concentrations in packages by Analog and in lidded devices by Tessera. Samsung shows a broad distribution of target applications in both their pending patent applications and issued patents (Figure 7).

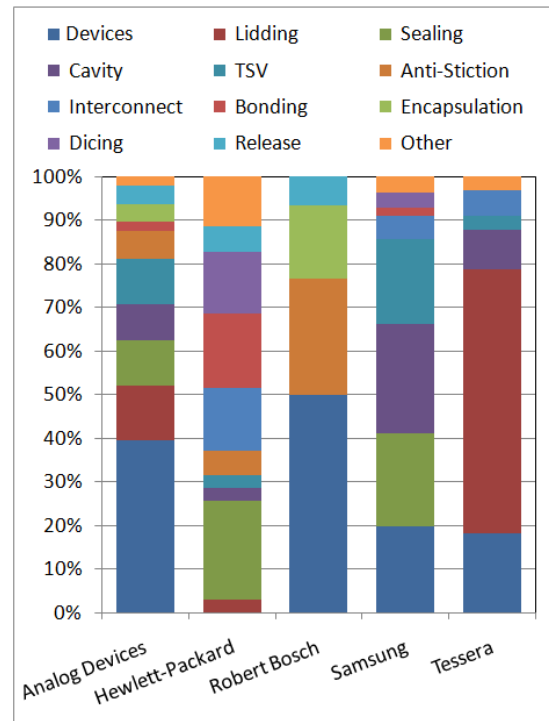


**Figure 8.** Distribution of market applications targeted in leading MEMS packaging portfolios (pending patent applications only)

Another view of the leading portfolios results from identification of key subject matter claimed in the patents and applications. Key subject matter groups found in these portfolios include (in order of frequency):

- MEMS device structures
- Lidding
- Sealing
- Cavity packages
- TSV or Through Silicon Vias
- Anti-Stiction technologies
- Electrical interconnect
- Bonding
- Encapsulation and molding
- Dicing or singulation
- Release methods

Figure 9 shows the distribution of these subject matter groups in patents and pending applications for leading portfolios while Figures 10 and 11 show the respective subject matter distributions for patents only and patent applications only.



**Figure 9.** Distribution of key subject matter in leading MEMS packaging portfolios (patents plus pending applications)

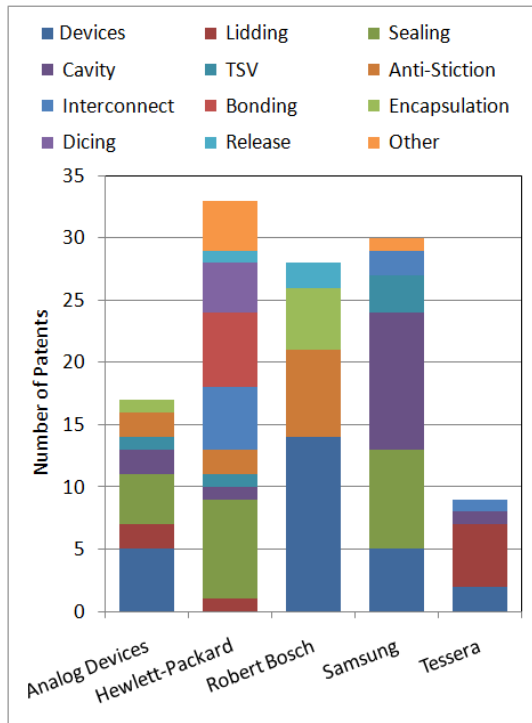
This analysis echoes the patterns seen in Figures 6, 7, and 8. In particular we note a strong emphasis by Tessera in the lidding area while Samsung and Analog hold broad distributions of subject matter within their MEMS packaging portfolios. Half of Bosch’s entire MEMS packaging portfolio relate to device structures.

While strongly represented in issued patents assigned to Analog, HP, and Samsung, patent applications for these firms deemphasize sealing technology possibly indicating a shift toward wafer-level processes as an alternative. The data also show a similar de-emphasis of cavity packages from issued packages to pending applications.

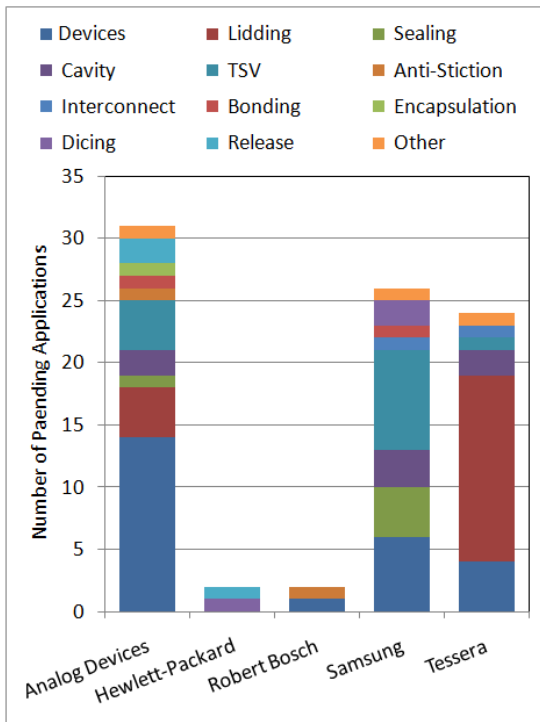
## CONCLUSIONS

The authors demonstrated a methodology to analyze patent applications to provide insight into competitive strategies in emerging markets using MEMS packaging as an example. In emerging fields, patent applications typically out-number issued patents. Transient in nature, patent applications reveal the intentions and aspirations of the assignee, which often undergo substantial revision before finalization as an issued patent (or rejection altogether). Because early filing preserves IP rights, and because patent law requires publication of pending applications, patent applications

provide a powerful window into competitive strategies in emerging markets.



**Figure 10.** Distribution of key subject matter in leading MEMs packaging portfolios (patents only)



**Figure 11.** Distribution of key subject matter in leading MEMs packaging portfolios (pending patent applications only)

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