



A Study Of Power Semiconductor Packaging Trends Using Topic Modelling

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Abstract

An analysis was performed on the packaging technology for power semiconductors for electric vehicles. Topic modelling was performed by applying the LDA technique by deriving the error by collecting unstructured research data. It was classified into various topics, and the extracted words for each topic were the definition of technology. Hot topic by topic through regression analysis of frequency by year for trend analysis of each topic and Cold topics were derived, and the trends of power semiconductor packaging technology were analysed. Construction according to withstand voltage Crude technology, input/output related control technology, and heat dissipation technology were derived, and inductance reduction technology was derived. This study will encourage more diversity when performing topic modelling and help determine what topic modelling method best suits.

Keywords: Semiconductor, Power, Regression Analysis, Topic Model, IGBT

Introduction

Due to restrictions on fossil fuels, the era of electric vehicles is rapidly approaching. Point is coming and growing more than 26% every year. In the conventional and hybrid electric vehicle market, power semiconductors are a crucial part of Switching and controlling the motor drive through the change of electric power used to perform the Fuel efficiency of eco-friendly vehicles (km/kW). As the importance of improvement increases, power semiconductors for cars are also growing [3]. In particular, the inverter of electric vehicles is used to drive the traction motor for operating the vehicle. Power semiconductor is a crucial component, and reliability has been proven in the market parts from advanced foreign companies are being applied in the form of a monopoly.

Therefore, domestic companies secure product competitiveness and become friends in technology dependence. To achieve this, the localization of power semiconductors [6-7] is essential. However, India's memory semiconductor field is the world's best Power semiconductors with different quasi- or industrial characteristics are included. The non-memory system semiconductor field is still a weak area. have a joe A peninsula that is overly biased towards memory products. Due to the characteristics of the system innovation system, the non-memory system, despite its growing importance in the global semiconductor market, has a deformed structure in which development is

relatively delayed. Accordingly, in 2013, the Ministry of Trade, Industry, and Energy Systems semiconductor industry through the announcement of a strategy to take off again in the conductor industry. It was selected as a priority task among the seven core promotion tasks.

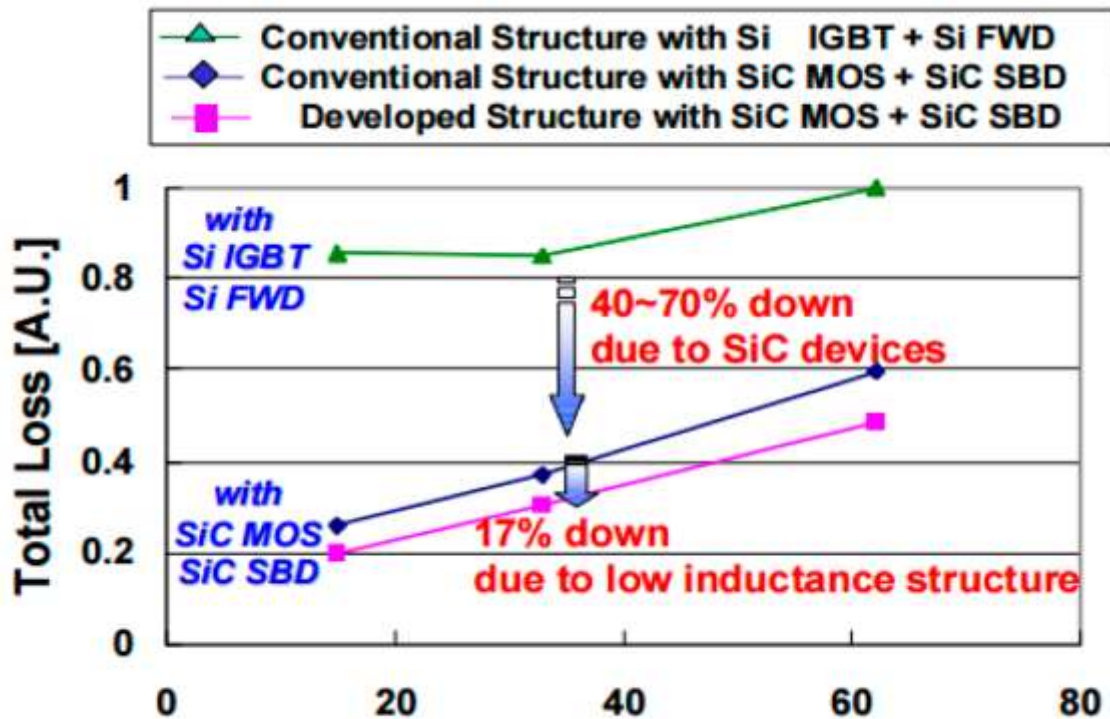


Figure 1: SiC

The leading technologies of the power semiconductor industry can be divided into two categories. First, the device technology is compatible with diodes in a high-temperature environment. Unipolar devices such as MOSFETs and JFETs, and HEMTs and IGBTs. It is classified as a microdevice, and with the recent surge in demand for power semiconductors, many words are reported. Second, in the power semiconductor, the reliability design of the module is another critical area [10]. The lifetime of the device deteriorates. Therefore, the device can be packaged well, and the technology that exists is as important as the technology of the device itself. Several advances in the technological trend of power semiconductor packaging technology. According to [3], looking at the study, cost, reliability, and efficiency form Comprehensive requirements in terms of weight and volume. In particular, the led development of power packaging technology intensively crossed. Innovations in materials interconnection and processing technologies have resulted in power. The module has been greatly improved.

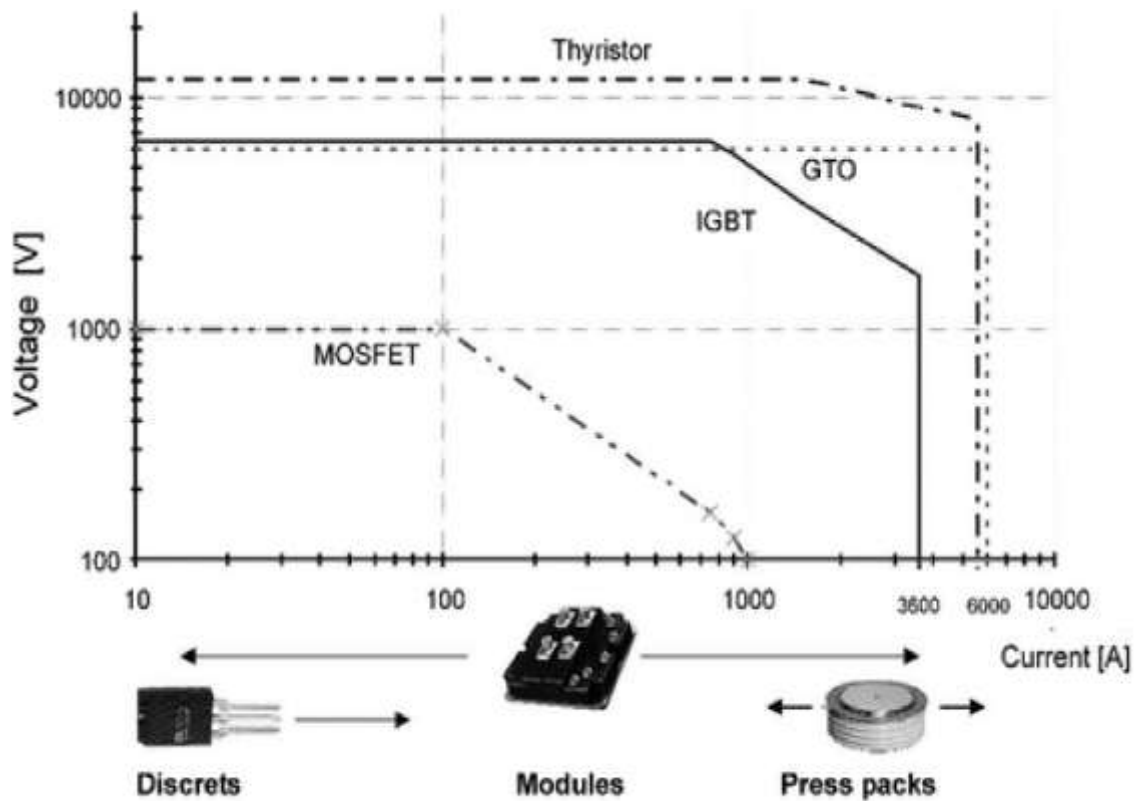


Figure 2: Unipolar Devices

- ⌘ The development technology and trends in module packaging with examples of industrial products. Reports reviewed and evaluated the technical details and Analysis of problems and development directions for power module packaging.
- ⌘ The IGBTs have higher operating temperatures and higher current densities. The heat dissipation inside the silicone increases when maximum operating temperature is generated, so future power module needs. To keep up, new packaging technologies are needed, two chip junction related powers for interconnection between packaging technology trends were compared.
- ⌘ The power module packaging technology has excellent performance. As new SiC power devices become commercially available, and the challenges facing standard packaging today, Requirements and recent packages that power module packaging must meet For power module packaging technology focus on the development of ne introduced.
- ⌘ It is also widely used for packaging SiC devices. Review the current standard power module architecture used and why do we need to develop packaging technology for high-speed switching, thermal tubes. The analysis was conducted in relation to the temperature of the insulation, high-temperature operation and high-voltage insulation.
- ⌘ Finally, the pendulum towards the new soft-switching power converters There are non-traditional module configurations, the same as for aerospace applications is a

low-temperature application in SiC packaging for potential application. The main issues of a new field of problem were not introduced.

In this way, the technology trend in the power module packaging industry being very significant. But so far, most of the research is qualitatively divided based on the analytical capabilities of some researchers. Analysis of technology applied to products originating in the stone and market is the loan is a minute. However, the control system of power module packaging technology is for electric vehicles. Research on quantitative and technical analysis and prediction is unsatisfactory for this type of technology. The prior quantitative research on technology prediction may be going through by US patent for hydrogen energy and fuel cell technology. Through the logistic growth curve model using the data of research. The group presents the growth curve for each technology system and patent strategy. Promising technology is defined according to the concept of Several things like Emerging technology, Key technology.

Analysis and exploration of promising technologies according to the diversity of these concepts. The Colour can be classified into quantitative, qualitative, and integrated analyses. Quantitative analysis using statistics, trend analysis, machine learning, etc. Qualitative by analysis method, Delphi, survey, scenario analysis, etc. An analytical approach, quantitative methodology, and qualitative method mutually complementary and integrated methods are being used. The Promising technology research using publication information during quantitative analysis is dynamic topic analysis is simple technical details. In addition, it is helpful for research on technological competitiveness and technology development direction [17]. To identify trends in technological development and change to ensure that companies and countries are growing forward. Receive innovation strategies such as R&D direction design, investment, and business strategy from respective authorities. It is used as an objective indicator for conducting research accurately. Therefore, this study is instrumental in the field of non-memory semiconductors. Useability data is required for the power semiconductor package industry for trains the system to predict technology trends. This study provides you the basic information that you can apply in research.

Research method

The purpose of this study is technology trends in electric power semiconductors for vehicles. For analysis, First, we collect information in related fields and then pre-process data and apply the topic modelling. Subsequent topics and the frequency of topics are derived by year. The best topics are classified into hot and cold through regression analysis.

Topic Model

In this study, the LDA model representing the topic model was used. LDA [4,6,7,9,11,15,18] is the potential for each document for a given set of documents.

Dirichlet probability distribution for the existence of a topic. A generative probabilistic model that judges based on a Model.

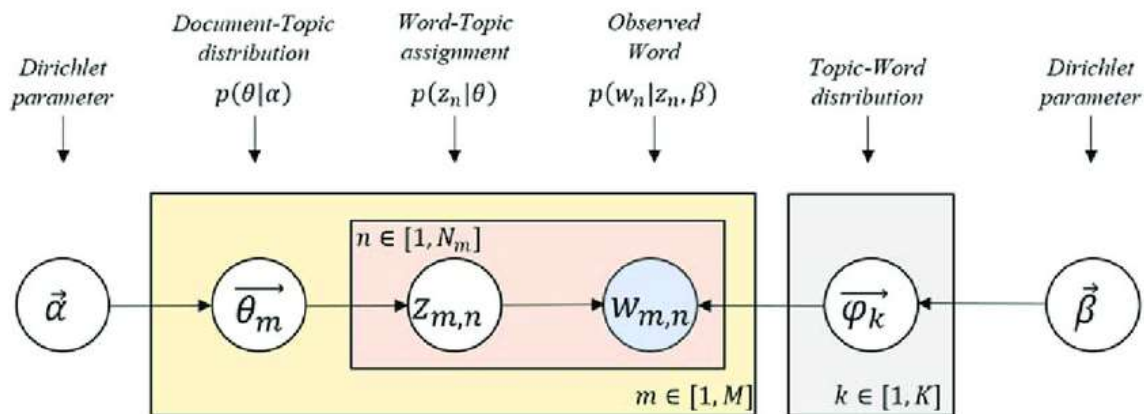


Figure 3:LDA

α and η are hyperparameters, and β is the Topic as a parameter of Dirichlet probability distribution determined by solution. Star word generation probability. Words observed in document and then topics are generated, and the topic ratio θ at which the corresponding document is generated. It is a value that follows the Dirichlet distribution and is determined by the weight of α . Z is defined from θ as the topic ratio for each document. K is the number of topics, M is the total number of documents, and N is the number of words that indicates the number. That is, M sentences with N -words. The topic ratio θ is determined, and the Topic of each word is indicated by θ .

Probability Density Equation

$$p(\theta|\alpha) = \frac{\Gamma(\sum_{i=1}^k \alpha_i)}{\prod_{i=1}^k \Gamma(\alpha_i)} \theta_1^{\alpha_1-1} \dots \theta_k^{\alpha_k-1}$$

The value of z is determined and forward for next step. Also, according to the value of η , the words for each topic indicating the frequency of words. The value of β is the generation probability, and finally determined by z and β . A document w , which is a set of N , is determined. Document sets are topics, and topics are made up of words, so estimate the distribution of words and topics and repeat this process, and You can identify the topic and move forward for further investigation about topic.

Data collection and pre-processing

Provide data for a particular field with the required information and relevant authority. Keywords for dataset collection of Power semiconductor packaging technology were collected using The search expression is “(((POWER or power) and (module or Switch or Switching)) and (Semiconductor)) or (((power) and (module or switch*)) and (semiconductor*)) and (package* or package or packaging).” The keying technology is regarded as a technology that can be used in all industries. There was no restriction on

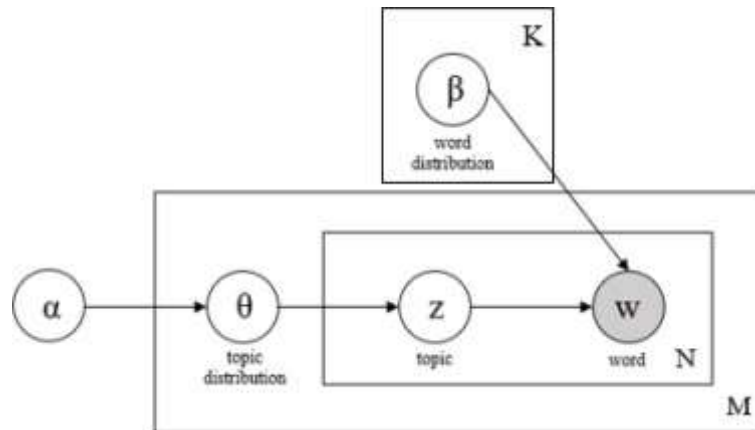


Figure 4: Process Flow

electric vehicles when collecting the dataset. A valid patent is a self-developed method using keywords. They proceeded through coring and suitable for title, summary, and claims. Valid Claims are scored in the order of the most keywords selected as the primary priority.

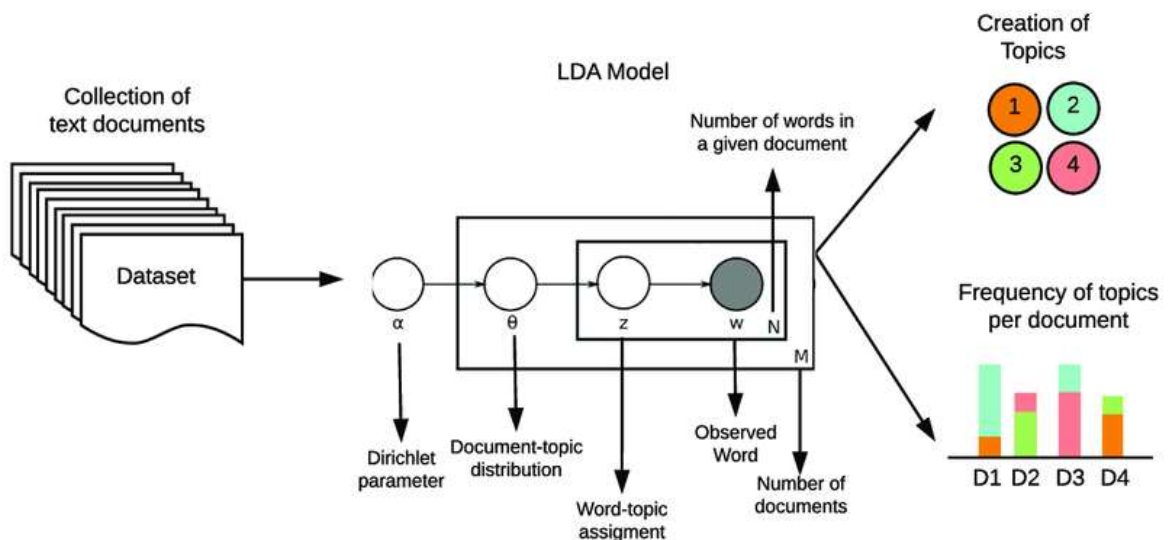


Figure 5: LDA Technique

Analysis

Each Word Frequency of Collected data to identify core technologies in the power semiconductor field. The highest frequency, and the main words are indicating the Chip, Device, Connect, Terminal, Substrate, etc., appeared.

The probability value among the topics and number of words derived within the matter is high-level words and technical definitions for each topic. The topic of each topic is a group that appears with a high probability in each topic. The name of the topic is indicated by a combination of words.

It can be inferred that many studies have been continuously conducted since Therefore, it can be considered as a hot topic. If the topic appeared as inductance reduction technology frequency is low, which means that the importance of inductance-related research is low rather than a basic power module technology, it is the subject of an application. It is reasonable to view that interest in technology is declining. Power semiconductor packaging is used in electric vehicle inverters. It can be divided into several types. The most important part is electrical signals. Load from the power source with on/off switching Power classified as that converts Power to (Load). MOSFETs, IGBTs, and diodes are used as standard products as sieve elements.

The main components of power module packaging are mechanically, thermally, and electrically and should be able to be connected stably. Solders such as SnPb and SnAgCu as bonding materials for accessories Alloys are mainly used. Important properties are:

- Other suitable melting temperatures.
- Compatibility with components.
- Mechanical strength degree.
- Low modulus of elasticity.
- High creep and fatigue resistance.

There are thermal conductivity and thermal expansion coefficients. Wire bonding process I/O terminals of power semiconductors, electrical conductors, and modules to electrically connect between them. Used for wire bonding A common material used is aluminium, and the power rating is good. In the case of high-power modules, when the resistance is lowered and the thermal performance is improved, Wire bonding or ribbon bone of heavy aluminium can be used. The primary purpose of melding technology is to protect semiconductor devices and components assembled with wires from moisture and breakdowns. Therefore, it functions as a medium for electrical insulation and heat dissipation.

Conclusion

The research is suitable for the recently rapidly growing electric vehicle. Quantitative technology trend analysis can be performed to analyse the trend of used power module packaging technology. Using the topic model and regression analysis can determine whether the topic priority is hot or cold topic, which is a technical indicator. Power semiconductor Collecting data in respective fields to package technology and topic

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modelling and regression analysis using only valid claims of novelty. Technology was used to classify the technology, and trends for each technology were analysed. Adequate words were derived through data processing such as pre-processing and topic modelling. Performing regression analysis on the techniques extracted with a design showing an upward trend for a method is a hot topic.

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