Original Research Article

Ideational Grammatical Metaphor in Electrical Engineering Abstracts

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Abstract

Ideational grammatical metaphor is an important aspect of systemic functional linguistics as well as widely present in academic abstract. According to the classification of 13 types of ideational grammatical metaphors by Halliday, this paper probes into their characteristics in English abstracts of 30 electrical papers, and compares the differences of ideational grammatical metaphors used by Chinese scholars and native English scholars. In this study, it can be found that domestic electrical engineering scholars have the following problems in writing abstracts: overuse of nominalization, underuse of the verbalization of conjunction, insufficient use of some types and low lexical variation.

Keywords: Ideational Grammatical Metaphor; Electrical Engineering Abstract; Nominalization; Verbalization.

1. INTRODUCTION

In recent years, the research on the language of academic papers has been widely concerned by experts and scholars at home and abroad, and the abstract has become one of the key research objects of linguists. The research involves many aspects and angles, including not only the classification and characteristics of the abstract, but also the macro structure and stylistic characteristics of the abstract, as well as the linguistic characteristics of the abstract and the pragmatic functions of the modifier. Research on abstracts of scientific and technological papers has begun to take shape, focusing on the classification of English abstracts of research science and engineering papers by major categories, mainly including comparison of use of shell nouns and their lexicogrammatical patterns in the thesis abstracts by Chinese-speaking science and engineering majors and English-speaking science and engineering majors (Liu, *et al.,* 2016);interpersonal functions in English abstracts of academic journals for science and engineering category (Yu, 2015); absence of hedges in English abstract of master's thesis (Yu, 2019); pragmatic failure analysis of English abstract of bachelor's thesis (Guo, 2011);the language features of science and engineering in abstracts of academic papers written(Pan, *et al.,* 2021),etc. In specific subject areas, researchers are determined to explore the English abstracts of medicine (Chu, *et al.,* 2014; Ao, 2010), petroleum (Li, *et al.,* 2013) from systemic functional grammar, but less involved in the field of electrical engineering. These scientific papers reflect scientific research, experiments, and technological development as a specialized genre, using language to truthfully reflect and reproduce objective truth. With the rise of functionalism, there has been a fundamental change in the understanding of the relationship between language and the world in the linguistic community, which has gradually influenced the cognition of technical language from "descriptive" to "metaphorical". Metaphor not only plays an indispensable role in the interpretation of scientific theories, but also is an important component in constructing scientific theories. Boyd (1979) argues that metaphors in scientific discourse can be divided into two categories: theoretical-constitutive metaphor and explanatory metaphor, but both types of metaphors are ideational metaphors at the lexical level, also known as lexical metaphors. At the level of grammar, Halliday proposed the concept of grammatical metaphor, which provides a new perspective for the study of scientific and technological discourse. Like lexical metaphor, grammatical metaphor can also reorganize human experiential meanings (resemanticizing). Moreover, grammatical metaphor can express the same thing in different ways, not just limited to changing wording. The grammatical metaphors in technology English help researchers express difficult-to-manipulate human experiences as facts. Therefore, based on systemic functional linguistics and starting from ideational grammatical metaphor, this paper adopts a qualitative and quantitative method to analyze 30 English abstracts in the field of electrical engineering, exploring the stylistic features of English abstracts in this field, in

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order to inspire foreign language teaching, English learning, and the writing of electrical engineering abstracts.

2. LITERATURE REVIEW

Ideational grammatical metaphor is an important component of systemic functional linguistics and an important means of understanding the world. It can present complex and abstract things in a tangible and vivid way. Halliday formally proposed the term "grammatical metaphor" in his Introduction to Functional Grammar, dividing it into ideational grammatical metaphor and interpersonal grammatical metaphor, and also proposed the concept of "congruence" as "explanatory models of experience", extending the study of metaphor to the grammatical level, and subsequently modifying and improving the theoretical framework of grammatical metaphor. Metaphorical expression refers to the use of expressions that are inconsistent with the "norm", such as using nouns to represent processes or using verbs to express certain concepts, making the meaning expressed at the

lexical-grammatical level inconsistent with the deep meaning to be expressed at the semantic level. Afterwards, Halliday summarized thirteen types of ideational grammatical metaphors and divided them into four categories: nominalization, adjectivization, verbalization, and prepositionalization. Specifically, the ideational metaphor of nominalization includes five situations: quality, process, circumstance, relater, and zero element to entity; the ideational metaphor of adjective includes four situations: process, circumstance, relater and entity to quality; the ideational metaphor of verbalization includes three situations: circumstance, relater and zero element to process; and the ideational metaphor of preposition has only one situation, which is manifested in that relater is converted into circumstance. Nominalization and verbalization are the main forms of ideational grammatical metaphor. The implementation of ideational grammatical metaphor in technology discourse relies on the forms of nominalization and adjectivization. Among them, the most frequent form of nominalization is to treat processes and quality as objects, and its structural shift is to correspond clauses to noun phrases.

Table 1: Categories of Ideational Grammatical Metaphor

Semantic element	Grammatical function	Grammatical class
quality→entity	epithet→thing	adjective→noun
process→entity	event→thing	verb→noun
	auxiliary→thing	
	catenative→thing	
circumstance→entity	minor process→thing	preposition(al phrase)→noun
	location, extent→classifier	
relater→entity	conjunction→thing	conjunction→noun
process→quality	event→epithet/ classifier	verb→adjective
	auxiliary→epithet/ classifier	
	catenative→epithet/ classifier	
circumstance→quality	minor process→epithet/ classifier	preposition(al phrase)→adjective
	location, extent→epithet/ classifier	
relater→quality	conjunctive→epithet	conjunction→adjective
circumstance→process	minor process→process	preposition(al phrase)→verb
	location, extent→process	
relater→process	conjunctive→event	conjunction→verb
relater→circumstance	conjunctive→minor process	conjunction→preposition(al phrase)
	conjunctive→Location, extent	
+entity	+thing	+noun
+process	+event(happening)	+verb
	+event(causal)	
	+event(phasal)	
entity→expansion	thing→qualifier	noun→various
circumstance→quality	manner→epithet	adverb→adjective
circumstance→quality	location, extent→epithet	prepositional phrase→adjective
circumstance→	location, extent→possessive	adverb→various
circumstance→	location, extent→qualifier	preposition phrase→various

Although the theory of grammatical metaphor has only a development history of three or four decades, scholars' enthusiasm for its research is increasing day by day. In recent years, most of the existing research on grammatical metaphor has been explored from a

theoretical perspective, in order to further improve the related theoretical framework or clarify its theoretical basis. The theoretical exploration mainly involves the theoretical sources and development of grammatical metaphor (Halliday, *et al.,* 2004; Jiang, 2014), the

semantic change of grammatical metaphor (Cong, *et al.,* 2013; Lin, *et al.,* 2010), the category and representation of grammatical metaphor (Halliday, 1998; Peng, 2018), etc. These studies have expanded the younger generation's understanding of language variation and laid a theoretical foundation for empirical research on grammatical metaphors. Empirical research generally focuses on the following areas. First is the study of the development and acquisition of grammatical metaphors. Painter (2003) found that the use of grammatical metaphors in the mother tongue increases as children's language proficiency develops through research on children's grammatical metaphors. The use of foreign language grammatical metaphors is also constrained by the level of foreign language proficiency, and there are significant differences in the quality and quantity of use between high and low proficiency groups, which are influenced to some extent by mother tongue transfer (Xiong, *et al.,* 2005) and cognitive developmental characteristics (Zhang, *et al.,* 2013). In second language acquisition, the input and absence of grammatical metaphors have an impact on learners' linguistic awareness to some extent (Li, 2009). The second is the study of grammatical metaphors as a linguistic feature in academic discourse. Grammatical metaphor is a distinctive feature of academic language, which can promote the development of argumentation and enhance the objectivity and authority of discourse (Halliday, Martin, 1993), and is one of the indicators reflecting the complexity of language (Ryshina-Pankova, 2015). Finally, the empirical study closely related to this research is the study on the complexity of grammatical metaphors in academic discourse of Chinese English learners. Liardét's (2013, 2016) research found that although the use of grammatical metaphors in Chinese English learners' compositions shows a developmental trend, there are still many problems in metaphor manipulation, and the discourse function of grammatical metaphors has not been fully realized. Zhong and Chen (2015) found through analyzing the use of grammatical metaphors in English academic papers written by

Chinese students that there are problems such as a single type of metaphor, individual collocation errors, and unclear causal relationships in Chinese learners' discourse, indicating that Chinese learners have certain difficulties in producing grammatical metaphors.

However, there is still a lack of corpus-based studies comparing the use of grammatical metaphors in English abstracts written by Chinese scholars in the electrical field and those by native English speakers in existing empirical research. Therefore, this paper aims to fill this gap by exploring this aspect. This study attempts to reveal the following two questions：

1) Are there differences in the use of ideational grammatical metaphor between Chinese scholars and English native speakers in their electrical engineering abstracts?
2) What are the characteristics of Chinese electrical scholars in the use of ideational grammatical metaphor? What are the reasons for these characteristics?

3.Corpus and Annotation
3.1 Corpus
The corpus for this study is selected from Electric Engineering Abstract Corpus from a university in north China, which is derived from academic papers in top 15 authoritative international electrical engineering journals. The content covers the forefront of electrical science research, and the foreign authors are electrical researchers whose native language is English. The corpus contains a total of 640 abstracts. Fifteen foreign and fifteen Chinese abstracts were randomly selected as the research objects for this paper. The length of each abstract is between 85 and 222 words, with an average word frequency of 166 words per abstract. The Chinese electrical abstracts are named CEA (01-15), and the English electrical abstracts are named EEA (01-15) (see Table 2).

**Table 2: Information on Chinese and English Electrical Corpora**

Corpus	Text	Tokens	Types	TTR
CEA	CEA01	130	75	0.577
	CEA02	101	69	0.683
	CEA03	110	61	0.555
	CEA04	106	66	0.623
	CEA05	177	99	0.559
	CEA06	156	82	0.526
	CEA07	136	80	0.588
	CEA08	160	95	0.594
	CEA09	85	59	0.694
	CEA10	150	88	0.587
	CEA11	173	95	0.549
	CEA12	123	71	0.577
	CEA13	203	109	0.537
	CEA14	163	105	0.644
	CEA15	193	92	0.477

Average		144.4	82.06	0.568
Total		2216	1246	0.575
EEA	EEA01	178	106	0.596
	EEA02	198	123	0.621
	EEA03	196	125	0.638
	EEA04	183	95	0.519
	EEA05	189	100	0.529
	EEA06	200	138	0.690
	EEA07	200	140	0.700
	EEA08	139	91	0.655
	EEA09	193	116	0.601
	EEA10	195	114	0.585
	EEA11	222	127	0.572
	EEA12	176	113	0.642
	EEA13	168	101	0.601
	EEA14	206	120	0.583
	EEA15	173	110	0.636
Average		187.73	114.6	0.610
Total		2816	1719	0.610

3.2 Annotation

This study uses UAM Corpus Tool3.3m to manually annotate 13 types of grammatical metaphors in the corpus (see Table 1), using the annotation framework shown in Figure 1.
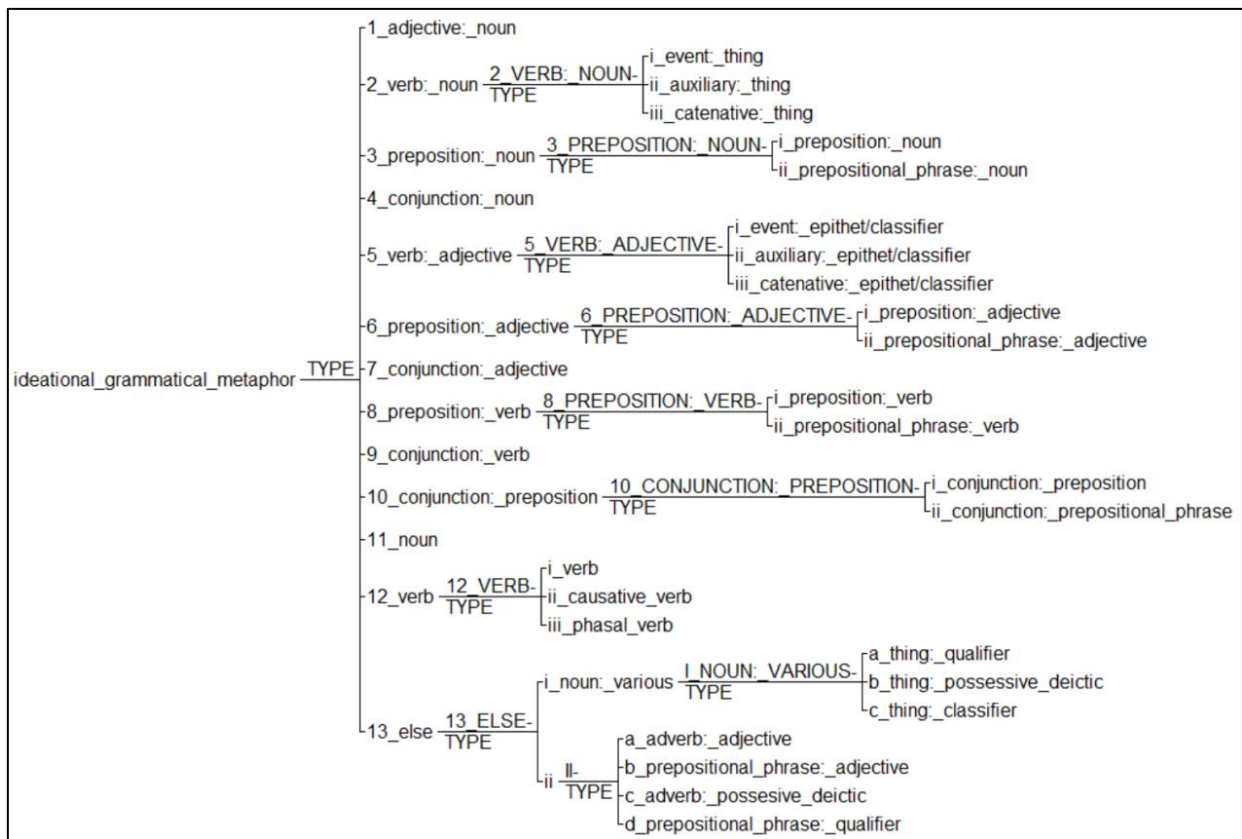
Figure 1: Framework of Ideational Grammatical Metaphor

Due to the reliance on context, manual annotation is suitable for judging ideational grammatical metaphor. Application can automatically detect morphological dependencies, but some inflections are not grammatical metaphors, and not all grammatical metaphors have inflections. Currently, automatic detection of ideational grammatical metaphor based on corpus application is limited to certain categories and requires large-scale data support, which is not applicable to this study.

In order to ensure the reliability of manual annotation, this paper adopts the form of multiple annotations to compare the differences between the before and after annotations, and discuss with classmates to clarify the annotation content and standards. In terms of annotated content, it does not include titles, explanatory content in parentheses, and proper nouns with initial capital letters, because in most cases they must use ideational grammatical metaphor and cannot reflect the selection ability of a certain language potential. In terms of judging criteria, the following principles have been adopted: 1) Semantic component and rank shift principle. As for the recognition criteria of English grammatical metaphor, most studies rely too much on morphological change and tend to nominalize (Derewianka, 2003; Byrnes, 2009; Zhou, *et al.,* 2017), has certain limitations. 2) No distinction is made between living metaphors and dead metaphors. Halliday (1998b,2004) distinguishes between insubstantial grammatical metaphor and systemic grammatical metaphor, and considers the latter to be a dead metaphor within the language system. The boundary between the two is too vague in practical judgment, so no distinction is made in this study. 3)non-typical syntactic nominalizations are not included in the statistics such as infinitives, embedded clauses, gerund phrases and so on (see Wang & Liu, 2011).

4. RESULTS

The final statistics of the frequency, ranking, and significance of various types of ideational grammatical metaphors are summarized as follows:

Table 3: Frequency, Ranking, and Significance of Ideatioanl Grammatical Metaphor

	CEA		EEA		
Feature	N/ 1000 words		N/ 1000 words		
Total Units	208	48.64	320	75.72	
Type	N=208		N=320		
	Frequency	Ranking	Frequency	Ranking	Signifi-cance
adjective→noun	14	6	19	7	
verb→noun	57	1	64	1	++
Preposition→noun	6	10	1	12	+++
Conjunction→noun	2	12	0	13	+
Verb→adjective	33	2	43	3	
Preposition→adjective	8	9	10	10	
Conjunction→verb	0	13	2	11	
Preposition→verb	9	8	20	6	
Conjunction→verb	4	11	18	8	++
Conjunction→preposition	13	7	11	9	
+noun	16	5	34	4	
+verb	18	4	64	1	+++
else	27	3	34	4	

+ Weak Significance 90%; ++ Medium Significance 95%; +++ High Significance 98%）

Due to the low frequency or even absence of some sub-types in certain types (such as Circumstance→Quality in Type 13), this study does not distinguish between sub-types.

The chi-square test shows that the ideational grammatical metaphor in EEA are generally more frequent than those in CEA, and some types have significant differences (p <0. 05). Types 2 (verb→noun), type 3 (preposition→noun), type 9 (conjunction→verb), and type 12 (+verb) all show significant differences (p<0.05). In terms of the frequency ranking of ideational grammatical metaphor types, the top three types are basically the same for both CEA and EEA, namely: Type 2 (verb→noun), Type 5 (verb→adjective), and Type 13 (else). The nominalization and adjective of verbs, as well as corresponding Type 13 (else), are more frequent in CEA and EEA than other types, confirming that nominalization and adjective of verb are important representations of grammatical metaphor. Specifically, the nominalization in CEA and EEA is far ahead of other types, so it can be further argued that the nominalization is the most powerful grammatical metaphor (Halliday, Matthiessen, 2014).

Most types show no significant difference (p>0.05). Types 1 (adjective→noun), type 5 (Verb→adjective), type 6 (Preposition→adjective), type 7 (Conjunction→verb), type 8 (Preposition→verb), type 10 (Conjunction→preposition), type 11 (+noun), and type 13 (else) have small frequency differences. Among them, types 4 (Conjunction→noun) and type 7 (Conjunction→verb) have low frequency and are difficult to distinguish their significance. Although type 4 (Conjunction→noun) has weak significance, it is still 90%＜p．＜95%, not persuasive.

Meanwhile, the TTR of each text is calculated, and it is found that the TTR in EEA is generally higher

than that of CEA, with as CEA TTR=0.575 and EEA TTR=0.610 (as shown in Table 2).

5. DISCUSSION

As mentioned above, Chinese electrical researchers use fewer grammatical metaphors as a whole than native speakers, and there are significant differences. This indicates that Chinese electrical researchers have weaker overall grammatical metaphor competences. In-depth analysis reveals the following problems with the use of ideational grammatical metaphor by Chinese electrical researchers: overuse of nominalization, underuse of the verbalization of conjunction, insufficient use of some types and low lexical variation.

5.1 Overuse of nominalization

Nominalization is the most important type of grammatical metaphor, including nominalization of preposition, of verb, of adjective and of conjunction. It is found that nominalization in CEA accounts for 37.98% of all types, while it is 26.25% in EEA, and the two have significant differences. Overall, there is an excessive use of nominalization, especially nominalization of preposition, which is 7.59% in CEA and 1.19% in EEA. For example:

Nominalization of Preposition

1) Related key technologies and policy suggestions were derived at last. (CC12) (metaphor)

Related key technologies and suggestions in policy were derived at last. (congruence)

In this case, circumstance is transformed as entity, from location/ location to classifier. In traditional grammatical class, it turns from prepositional phrase to noun, shown as suggestion in policy to policy suggestion.

In CEA, there is a significant proportion of nominalization of preposition. The reason for this is that nominalization of preposition transforms circumstance/location into entity, which is more stable in nature compared to circumstance/location.

Nominalization of Verb

2) To further promote the development and utilization of renewable energy is one of the critical goals of energy revolution in China while Energy Internet is the key solution to accomplish that task. (CC03) (metaphor)

To further promote to develop and utilize renewable energy which energy revolutionizes is one of the critical goal in China while Energy Internet is solved to accomplish that task. (congruence)

Nominalization of Adjective

3) This paper briefly compared and analyzed the

differences between the domestic and international distribution networks, summarizes the existing major problems in China, and gived corresponding suggestions for improvement. (CC10) (metaphor)

This paper briefly compared and analyzed the domestic and international different distribution networks, summarizes the existing major problems in China, and gived corresponding suggestions for improvement. (congruence)

Nominalization of Conjunction

4) At last, the energy sub grid pattern with an energy-hub was researched, and some operation conditions in computer simulation, were presented, and its feasibility and validity were demonstrated. (CC02) (metaphor)

At last, the energy sub grid pattern with an energy-hub was researched. If there are some operations, they were presented. And its feasibility and validity were demonstrated. (congruence)

The output of nominalization is the process of information compression or packaging, which abstracts meaning. And the understanding of nominalization is a reverse unpacking process. However, meaning abstraction makes unpacking very difficult, with diverse results and even failure. The grammar and knowledge construction of scientific discourse often reflects its discursive power and distinguishes it from daily language through this approach (Halliday, 1998). Too much nominalization of preposition can lead to negative effects. For example, Pinkham (2000) argues that Chinese English suffers from a proliferation of nouns, which makes the text complex, redundant and obscure. Therefore, when writing English abstracts, Chinese scholars need to pay attention to the frequency of nominalization of preposition and reduce unnecessary use to avoid misinformation or misinterpretation by readers.

5.2 Underuse of the verbalization of conjunction

In the electrical abstract, it is found that there are too few instances of verbalization of conjunction (Type 9 Conjunction→Verb) in China. In EEA, verbalization of conjunction accounts for only 1.92% of all types, while it is 5.63% in EEA, and there is a significant difference between the two.

5) Results showed that the model could make a balance between security and economy while optimizing wind power integrated system. (CC05) (metaphor)

If results are true, the model could make a balance between security and economy while optimizing wind power integrated system. (congruence)

In this case，relater is transformed as process, from conjunctive to event. In traditional grammatical class, it turns from conjunction to verb, presented as "if results are true..." to "results showed that...".

5.3 Insufficient use of some types

Domestic learners not only have the problem of overuse of nominalization and underuse of the verbalization of conjunction, but also have insufficient use in some types, such as type 8 (Preposition→verb) and type 9 (Conjunction→verb). Examples are given as follows:

6) However, the resonance issues bought by the power converters have been a great threat to the safety and stability of power system operation. (CC06) (metaphor)

However, the resonance issues of the power converters have been a great threat to the safety and stability of power system operation. (congruence)

7) Then a modulation function is derived from minimizing the cost function which evaluates the current error. (CC15) (metaphor)

The cost function which evaluates the current error minimizes, so a modulation function will be get. (congruence)

Based on the findings that there is overuse of nominalization, underuse of the verbalization of conjunction, insufficient use of some types, it is believed that although domestic electrical researchers have the overall competence of ideational grammatical metaphor, their mastery of various types is not balanced, which may be related to classroom teaching, discourse research, and mother tongue transfer, and further research is needed.

5.4 Low lexical variation

Type-Token Ratio (TTR) is a commonly used method to measure the lexical density of text, which can help indicate the vocabulary difficulty of the text. The higher the TTR, the richer the vocabulary used in the text, and vice versa. Statistical results show that in the abstracts of electrical engineering papers published by Chinese scholars in international journals, the TTR is generally lower than that of native English-speaking researchers (0.610), as shown in Table 1.

Taking Type 11(+noun) as an example, domestic researchers generally use provide, make, have, meet, establish, etc, while English native scholars also use extend, satisfy, apply, aid, rely on, overlook, examine, formulate, put forward to promote, etc, on this basis.

Most recent research has relied on the DC approximation of the power flow model in the optimal transmission switching problem. (EE01)

8) The hybrid optimization algorithm can solve large-scale mixed-integer nonlinear optimization problem accurately and rapidly, which also satisfies the demand of time-series optimization problems.

9) Cylinder pressure diagrams and related heat release rate analysis disclose and aid the interpretation of the differences observed in combustion attributes among all bio-fuels blends. (EE02)

There are two possible reasons for the low TTR figures. First, the vocabulary of English learned and used as a foreign language in China is far less rich than that of native English researchers, so the English vocabulary of Chinese scholars who publish papers on top international journals is slightly lower than that of native speakers. Second, there may be a large number of functional words in the English abstracts written by Chinese scholars. Addition of a word in the text will increase a token, but not necessarily a type. In this way, the longer the text, the more functional words are repeated, the lower the TTR will be.

6. CONCLUSION

Grammatical metaphor is an important feature of academic discourse. Mastering grammatical metaphor is conducive to improving academic literacy and integrating it into the academic community of target language. Additionally, relevant empirical studies have confirmed that foreign language learners have a certain difficulty in acquiring grammatical metaphor (Liardet, 2013). Guided by the theory of systemic functional grammar, this paper analyzes 13 types of grammatical metaphors in electrical abstracts at home and abroad by combining quantitative and qualitative methods and ideational grammatical metaphors. It is found that most scholars at home and abroad use nominalization, among which Chinese scholars use too much nominalization, which is easy to cause readers' misunderstanding. Chinese scholars seldom use verb of conjunction, and the frequency of use is much lower than that of native language researchers. Some types are underused, such as type 8 (Preposition→verb) and type 9 (Conjunction→verb). The above three issues may be related to classroom teaching and mother tongue transfer. Finally, by calculating TTR, it is found that there is little lexical diversity in English abstracts of Chinese electrical scholars.

It should be noted that there are only 30 pieces of corpus studied in this article, and there are certain limitations in the number of samples, so the conclusion needs to be further proved. But to a certain extent, it points out the important and difficult points of writing electrical academic papers in foreign language teaching. It is hoped that this study will inspire the teaching of academic English writing, help Chinese English learners and electrical researchers understand the stylistic characteristics of English abstraction in electrical field, and improve their writing ability of academic discourse.

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