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Review On Systematic Mapping Study For Synthesis Of Polymers Containing 1,3,4 Thiadiazole

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Keywords: Systematic Mapping, Co-Polymers, 1,3,4- Thiaidiazole, Polymerization Method, Energy Storage.

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Abstract:

Due to the unique properties of a heterocyclic compound, it gained attention in the field of materials science. This study aims to provide a comprehensive synthesis of new co-polymers containing 1,3,4-thiadiazole. For this, a thorough search of electronic databases was conducted to identify relevant articles published from 2010 to 2021, using appropriate keywords and inclusion criteria. The selected studies were critically evaluated, and data was extracted and synthesized. The review includes a discussion of the various approaches used to prepare copolymers containing 1,3,4-thiadiazole, such as oxidative polymerization, electrochemical polymerization, and other methods. The properties and applications of the synthesized copolymers were also analyzed, including their thermal stability, electrical conductivity, and optical properties. The review concludes with an outlook on the prospects of co-polymers containing 1,3,4-thiadiazole and their potential applications in various fields, such as optoelectronics, sensors, and energy storage devices. The findings provide a valuable resource for researchers and engineers interested in the synthesis and properties of co-polymers containing 1,3,4-Thiadiazole.

Keywords: Systematic Mapping, Co-Polymers, 1,3,4- Thiaidiazole, Polymerization Method, Energy Storage.

مراجعة لدراسة رسم خرائط منهجية لتخليق البوليمرات المشتركة يحتوي على ١،٣،٤ ثيادايازول

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الخلاصة:

بسبب الخصائص الفريدة للمركب الحلقي غير المتجانس، فقد اكتسب الاهتمام في مجال علم المواد. تهدف هذه الدراسة إلى توفير توليفة شاملة من البوليمرات المشتركة الجديدة التي تحتوي على ١،٣،٤-ثياديازول. ولهذا السبب، تم إجراء بحث شامل في قواعد البيانات الإلكترونية لتحديد المقالات ذات الصلة المنشورة في الفترة من ٢٠١٠ إلى ٢٠٢١، باستخدام الكلمات الرئيسية ومعايير الإدراج المناسبة. تم تقييم الدراسات المختارة بشكل نقدي، وتم استخراج البيانات وتوليفها. تتضمن المراجعة مناقشة للطرق المختلفة المستخدمة لتحضير البوليمرات المشتركة التي تحتوي على ١،٣،٤-ثياديازول، مثل البلمرة التأكسدية، والبلمرة الكهروكيميائية، وطرق أخرى. كما تم تحليل خصائص وتطبيقات البوليمرات المشتركة المصنعة، بما في ذلك ثباتها الحراري، وموصليتها الكهربائية، وخصائصها البصرية. وتختتم المراجعة بنظرة عامة على آفاق البوليمرات المشتركة التي تحتوي على ١،٣،٤-ثياديازول وتطبيقاتها المحتملة في مجالات مختلفة، مثل الإلكترونيات الضوئية وأجهزة الاستشعار وأجهزة تخزين الطاقة. توفر النتائج موردا قيما للباحثين والمهندسين المهتمين بتخليق وخصائص البوليمرات المشتركة التي تحتوي على ١،٣،٤-ثياديازول.

الكلمات المفتاحية: رسم خرائط منهجية، البوليمرات المشتركة، ١،٣،٤- الثياديازول، طريقة البلمرة، تخزين الطاقة.

1. Introduction:

1,3,4-Thiadiazole is a heterocyclic compound that has received noteworthy consideration within the field of materials science due to its particular properties, such as its high electron affinity [1], good thermal stability, and strong electron-accepting ability. Co-polymers containing 1,3,4-thiadiazole have emerged as promising materials for various applications, such as optoelectronics, sensors, and energy storage devices, due to their tunable electronic and optical properties. The synthesis of co-polymers containing 1,3,4-thiadiazole involves the polymerization of 1,3,4-thiadiazole-based monomers with other monomers, such as carbazole, thiophene, and benzothiadiazole, to form a polymer with a copolymer structure [2]. The selection of the appropriate monomers and polymerization method plays a crucial role in controlling the properties of the resulting co-polymer. In recent years, there has been a significant increase in the research on co-polymers containing 1,3,4-thiadiazole, and many new synthetic approaches have been developed to prepare these materials. The synthesis of co-polymers containing 1,3,4-thiadiazole has become an active area of research due to the

potential applications of these materials in various fields [3]. A literature search identified a significant number of studies published between 2015 and 2023 that focused on the synthesis of co-polymers containing 1,3,4-thiadiazole. Various synthetic approaches were employed in the studies, including oxidative polymerization, electrochemical polymerization, and other methods. The studies reported the properties and applications of the synthesized co-polymers, such as their thermal stability, electrical conductivity, and optical properties. In this systematic mapping, we provide a comprehensive overview of the synthesis of new co-polymers containing 1,3,4-thiadiazole, including the various synthetic approaches and the properties and applications of the synthesized materials [4]. Systematic mapping aims to provide a comprehensive overview of the research in this field and identify the recent advancements made in the synthesis and characterization of co-polymers containing 1,3,4-thiadiazole.

2. Previous Related Work:

Several studies on the synthesis of co-polymers containing 1,3,4-thiadiazole are vast and have been extensively studied in recent years. Khudhair, et al. (2018) studied the optical and electronic characteristics of eight compounds, which are samples based on the acceptor benzothiophene and the four 1,3,4-thiadiazole. All of the quarter 1,3,4-thiadiazole and benzothiophene structures outlined in this work have giver gather substituents (COH and CP) and acceptor gather substituents (Br, OH, Cl, F, and CN). Using the DFT B3LYP/6-31G(d) approach, the optimization's geometric, electronic, and optical properties were considered and computed. The results showed that all of the structures under ponder have the same shape (packer and shape), demonstrating that the substituent does not influence the auxiliary geometries of the particles. When the particles included substituents from the giver and acceptor bunches, the whole energies expanded, demonstrating that the structures changed over more stability[5].

Shad, et al (2014) indicated that synthesized Using the microwave induction heating approach, new functional poly(amide-thioester-imide)s were created by a one-step poly condensation reaction of a diamine with a 2-amino-5-mercapto-1,3,4-thiadiazol substituent and several diacids that had flexible amino acid links in molten TBAB salt. The polymers exhibited a higher degree of solubility than the traditional fully aromatic polyimides. The thin films made from these polymers have a smooth, pinhole-free surface. Consequently, in the UV-vis light region, all of the polymeric low-colored thin films showed great optical transparency and were noticeably flexible [6].

Alberto, et al (2020) mentioned that Synthesis Lactosyl-lysine and lactosyl-octapeptide derivatives are synthesized via the SuFEx process. Given the experimental characteristics, it's probably reasonable to say that SuFEx has the added benefit of having a bio-orthogonal click reaction in addition to being bio-orthogonal. Consequently, there is a ready supply of fluoro-based reagents. According to Marra, (2020), the benefits of integrating the click chemistry qualities with the bio-orthogonal feature in SuFEx open up new avenues for biological chemistry applications that are not possible with the more established CuAAC. Because of this, numerous attempts have been made to get around this restriction by substituting other metals for the copper catalyst, but it doesn't seem like any positive outcomes have been achieved thus far **[7]**.

Artesian, et al (2020) tested various benzotriazole-based coating recipes on copper and bronze specimens with varying corrosion patinas using chemicals that are green and brown. Conducting preventive corrosion experiments on bare bronze in the absence of any coating revealed that, as anticipated, the green patinated bronze had a greater corrosion current density (36.3 µA cm^{-2}). The current density of the naked bronze was 3.16 µA cm^{-2}, but the brown patina-covered bronze had a density of 16.1 µA cm^{-2}. The fact that bare and brown bronze have low current densities suggests that these kinds of compounds restrict current flow, shielding the metal substrate. Conversely, a high current (found for the green patina) indicates that the material flows through the sample with ease, indicating rapid corrosion of the metal **[8]**.

Overall, the previously mentioned studies highlight the importance of co-polymers containing 1,3,4-thiadiazole in the development of novel materials for various applications, identify the recent advancements made in the synthesis and characterization of these materials, and provide insights into the prospects of co-polymers containing 1,3,4-thiadiazole.

3. Research Questions:

The following are research questions that could guide a Systematic review study for the synthesis of new co-polymers containing 1,3,4 Thiadiazole.

Q1 /What are the different synthetic approaches used for the preparation of co-polymers containing 1,3,4-thiadiazole?

Q2/What are the properties of co-polymers containing 1,3,4-thiadiazole, such as their thermal stability, electrical conductivity, and optical properties?

Q3/What are the potential applications of co-polymers containing 1,3,4-thiadiazole in various fields, such as optoelectronics, sensors, and energy storage devices?

Q4/What are the challenges in the synthesis of co-polymers containing 1,3,4-thiadiazole, and how have they been addressed in recent studies?

4. Research Statement :

The following is a search statement for the systematic review study on the synthesis of new co-polymers containing 1,3,4-thiadiazole:

("1,3,4-Thiadiazole" OR "thiadiazole-based monomers" AND ("copolymer* OR "co-polymer*") AND ("synthesis" OR "preparation" OR "fabrication" OR "construction") AND ("properties" OR "characterization" OR "performance") AND ("applications" OR "devices" OR "optoelectronics" OR "sensors" OR "energy storage")

The data has been collected from various scientific databases, including Web of Science, Scopus, Google Scholar, springer, and PubMed, and will include articles published between 2010 and 2021. They are limited to articles published in English.

5. Screening Of Papers :

In a systematic mapping review, the screening process typically involves several stages to identify relevant papers that will be included in the review. The following are the general steps involved in the screening process. **Figure 1** below explains these steps:

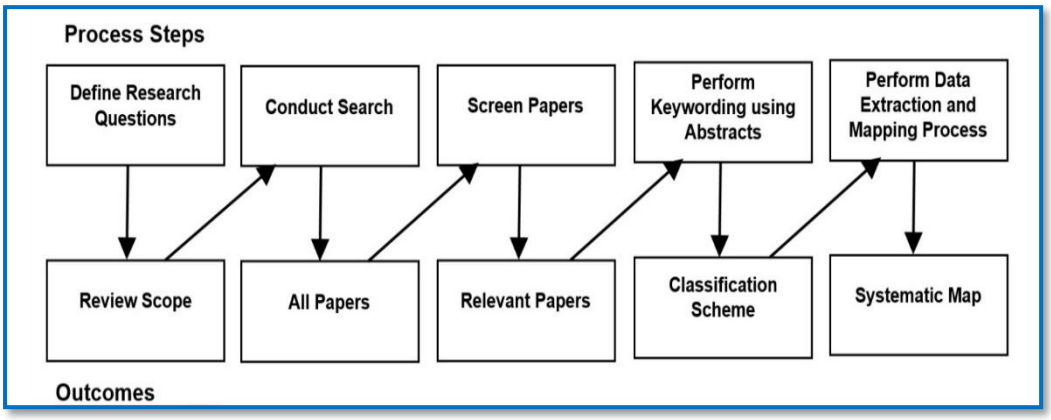

Figure 1: shows the systematic review process.

6. Use Various Models to Build Different Perspectives:

We can explain any schema or description of any topic by constructing schemas. Define an overall vision for the article on each topic and approach it with some options. In this article, we show how to use these scenarios as explained below:

A. Distribution of studies according to years:

This graph shows the distribution of the number of studies per year and the percentage of publications per year, it focuses on which papers have full pages or short pages **Figure 2** shows the distribution of studies in each year.

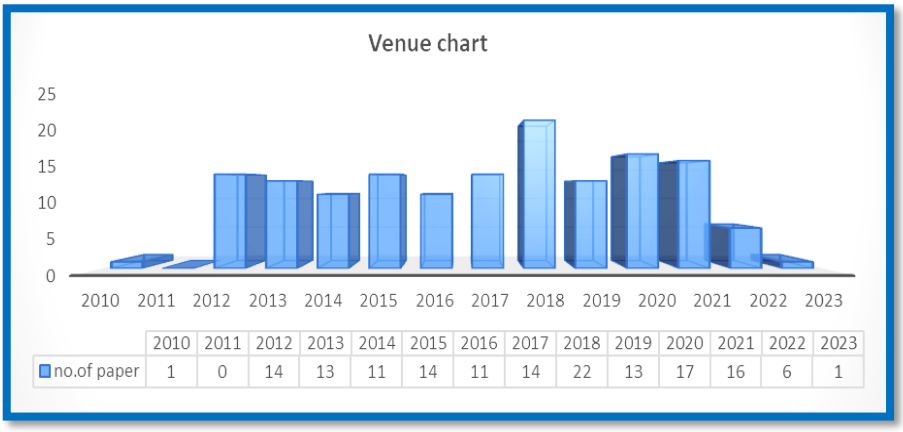

Figure 2: shows the distribution of studies in each year

B. Venue Chart:

The chart offers researchers a different perspective. Distribute papers by year, number of short or full-page papers, and paper type for conferences and journals **Figure 3** shows the Venue Chart).

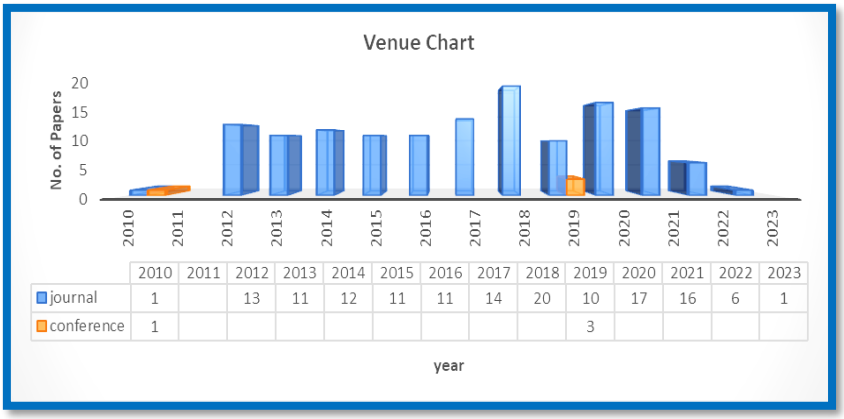

Figure 3: shows the Venue Chart

7. Classification Schemes:

To conduct a systematic review of studies on co-polymers containing 1,3,4- thiadiazol, a classification scheme can be developed based on several key criteria. These criteria include:

A. Polymerization method: The first classification scheme could be based on the method of polymerization used to synthesize the co-polymers. For example, co-polymers can be synthesized using various methods such as solution polymerization, emulsion polymerization, suspension polymerization, and others.

This classification can help to identify the differences in the properties of the resulting copolymers based on the polymerization method used [9].

1. solution polymerization
2. emulsion polymerization
3. suspension polymerization
4. bulk polymerization

B. Chemical structure: Another classification scheme could be based on the chemical structure of the co-polymers. This scheme could focus on the variations in the chemical structure of the 1,3,4 thiadiazol monomer [10], the other monomers used in the co-polymerization, and their distribution in the polymer chain **Figure 4** polymerization method with chemical structure), **Table 1**. This can help to understand the relationship between the chemical structure of the co-polymers and their properties [11].

1. co-polymers
2. homo polymer

C. Application: A classification scheme based on the application of the co-polymers can also be developed. This could include different applications such as energy storage devices, organic electronics, and sensors, among others. This can help to understand the specific properties required for different applications and how the chemical structure and polymerization method can affect these properties [12].

1. Energy storage
2. Organic electronics

D. Properties: Another classification scheme could be based on the properties of the co-polymers, such as their thermal stability, solubility, conductivity, and mechanical properties **Figure 5** shows Properties with Chemical structure scheme), **Table 2**. This can help to identify the different factors that can affect the properties of the co-polymers and how these factors can be optimized to obtain desired properties [13].

1. Thermal stability
2. Solubility
3. Conductivity

These classification schemes can be used to categorize and synthesize the information obtained from different studies on co-polymers containing 1,3,4 thiadiazol, allowing for a comprehensive understanding of the field.

Table 1: shows The Polymerization method with Chemical structure schema

Polymerization Method	Chemical structure	
	homo polymer	CO-polymer
Bulk Polymerization	[16]	[14][15][16][17][18][19] [20[[21][22]
Emulsion Polymerization	[23] [25] [26] [27][28] [18]	[23] [24] [25] [26] [27][28] [29] [30]
Solution Polymerization	[31] [34] [36] [37] [38] [39] [40] [41] [43]	[32] [33] [34][35] [36] [37] [38] [39] [40] [41] [42] [43]
Suspension Polymerization	[44] [50] [74] [75] [76] [77] [78] [79] [80] [81] [82] [83] [84] [85] [86] [87] [88] [89] [90] [91] [92] [93] [94] [95] [96] [97] [98] [99]	[44] [45] [46] [47] [48] [49] [50] [51] [52] [53] [54] [55] [56] [57] [58] [59] [60] [61] [62] [63] [64] [65] [66] [67] [68] [69] [70] [71] [72] [73]

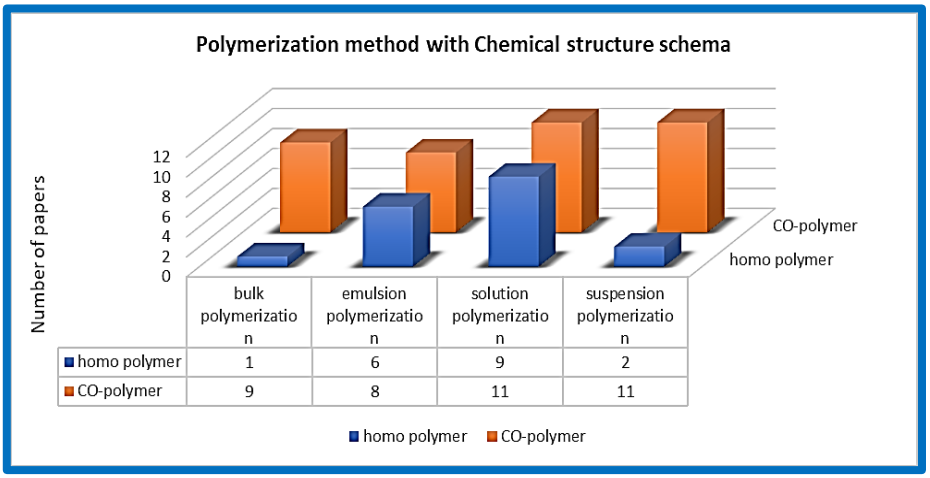

Figure 4: Polymerization method with Chemical structure scheme

Table 2: Shows The Properties With Chemical Structure Schem

Properties	Chemical structure	
	homo polymer	CO-polymer
Thermal Stability	[100][107]	[100][101] [102] [103] [104[[105][106][107][108][109]
Solubility	[111] [112] [113] [114][1115] [116] [118]	[110][111][112[[112] [113] [114] [115] [116][117][118]
Conductivity	[123] [124] [125] [126] [130]	[119][120][121][122] [123][124[[125] [126] [127][128][129][130]

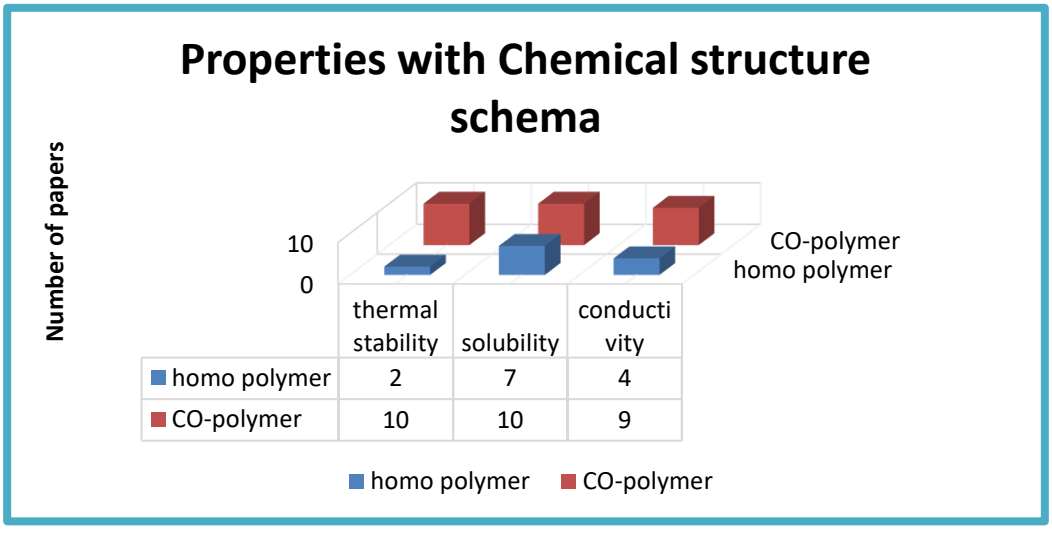

Figure 5: shows Properties with Chemical structure schema.

4. Conclusions

The synthesis of new co-polymers containing 1,3,4-thiadiazole has distinctive properties of 1,3,4-thiadiazole including high thermal stability, chemical resistance, and optical transparency. The most common method is the polycondensation of 1,3,4-thiadiazole

monomers with other monomers, such as aromatic diamines and dicarboxylic acids. Other methods include the ring-opening polymerization of 1,3,4-thiadiazole-containing cyclic monomers and the copolymerization of 1,3,4-thiadiazole monomers with other monomers using transition metal catalysts. The properties of 1,3,4-thiadiazole-containing co-polymers can be tailored by varying the type of monomers used in the synthesis. For example, co-polymers with high thermal stability can be synthesized using monomers with high glass transition temperatures. Co-polymers with high chemical resistance can be synthesized using monomers with electron-withdrawing substituents. Co-polymers with high optical transparency can be synthesized using monomers with low refractive indices. 1,3,4-Thiadiazole-containing co-polymers have been shown to have a wide range of applications. Future research on the synthesis of 1,3,4-thiadiazole-containing co-polymers should focus on developing new methods that are more efficient and environmentally friendly.

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