

# Development and design of external plaster patch based on high permeability

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**Abstract:** This paper explores the research and development of high-permeability external adhesive plaster formulations. It begins by introducing the basic concept of external adhesive plasters and the definition of high permeability, emphasizing its significance in pharmaceutical applications. Subsequently, it analyzes the current domestic and international research status and the development history of high-permeability external adhesive plasters, with in-depth analyses of several typical cases. In the section on technical and design elements, the focus is on the selection of permeable materials, structural design and manufacturing processes, as well as methods for controlling drug release and evaluating effectiveness. Finally, it examines the practical demands and market prospects of high-permeability external adhesive plasters in pharmaceutical applications, proposing directions for future research and recommendations.

**Keywords:** High permeability; External adhesive plaster; Pharmaceutical applications; Permeable materials

## 1. Introduction

With advances in medical technology and increasing health consciousness among the public, external adhesive plasters have gained widespread attention and application as a convenient and effective treatment method. However, traditional plasters have certain limitations in terms of permeability and comfort, affecting both the effective release of drugs and the comfort of users. Therefore, the development of high-permeability external adhesive plasters has become a hotspot in current research. This paper aims to explore the research and development of high-permeability external adhesive plasters. It begins by introducing the basic concept of external adhesive plasters and their importance in pharmaceutical applications, followed by an analysis of current research status and technological trends. The focus is on the application significance of high permeability in external adhesive plasters, with detailed discussions on key technologies and design elements such as the selection of permeable materials, structural design, and methods for controlling drug release. Finally, it explores the application prospects of high-permeability external adhesive plasters in the pharmaceutical field and suggests future research directions to promote further development and application in this field. Through this research, it is hoped to provide theoretical support and practical guidance for the development of more effective and comfortable external adhesive plasters, thereby promoting innovation and progress in medical technology<sup>[1]</sup>.

## 2. Concept and Definition of High Permeability External Adhesive Plasters

### 2.1. Basic Concept of External Adhesive Plasters

External adhesive plasters are pharmaceutical formulations that release drugs by attaching adhesive patches containing medications to the skin surface, utilizing the skin's absorption capacity to achieve therapeutic effects. Compared to traditional oral medications, external adhesive plasters act directly on localized disease sites, reducing drug breakdown and metabolism through the digestive tract, thus enhancing local drug concentration and effectively treating affected areas. External adhesive plasters typically consist of adhesive matrices and drugs. The adhesive matrix generally includes adhesives, thickeners, and transdermal enhancers to ensure drug stability and adhesion, while maintaining sufficient permeability to promote skin drug absorption. Depending on treatment needs, drugs can include analgesics, anti-inflammatories, and steroid medications to achieve therapeutic effects. The design of external adhesive plasters considers multiple factors such as skin irritability, drug release rate,

and duration of therapeutic efficacy. High permeability is a crucial feature in the design of external adhesive plasters, ensuring that the patch adheres to the skin while allowing free gas exchange, preventing local skin moisture and discomfort, and facilitating the effective penetration of drug components through the skin barrier to reach the treatment site. With continuous advancements in medical technology, the clinical application scope of external adhesive plasters continues to expand, covering areas such as pain management, dermatological treatments, and arthritis therapy. Their convenience, localized effectiveness, and minimal side effects make them a preferred treatment option for both patients and physicians<sup>[2]</sup>. Therefore, a comprehensive understanding of the basic concepts and design principles of external adhesive plasters is essential for further optimizing drug treatment effects and improving patient quality of life.

### ***2.2. Definition and Importance of High Permeability***

High permeability refers to the ability of materials or products under specific conditions to facilitate effective gas exchange and permeability. In external adhesive plasters, high permeability means that the patch can maintain close contact with the skin while allowing moisture evaporation from the skin surface, ensuring skin dryness and comfort. This characteristic not only promotes the rapid absorption of drug components on the skin surface but also reduces local humidity, avoiding skin infections and discomfort caused by moisture, and facilitating effective absorption of drug ingredients. External adhesive plasters, as an effective means of localized treatment, directly relate to the effective delivery of drugs to treatment sites and the sustainability of treatment effects. The importance of high permeability in external adhesive plasters is primarily reflected in several aspects: Firstly, good permeability effectively promotes the efficiency of drug absorption on the skin surface. By maintaining skin dryness and permeability, the patch allows drug components to quickly penetrate the skin barrier and reach the treatment site, thereby enhancing the speed and efficiency of treatment effects. Secondly, high-permeability patches can prolong the residence time of drugs at treatment sites, maintain continuous drug release, and thereby enhance the sustainability and stability of treatment effects, especially suitable for chronic diseases or symptom management requiring long-term treatment. Additionally, good permeability significantly improves patient treatment experience, reduces local discomfort during patch use, such as moisture and heat, and enhances patient treatment compliance and quality of life. High-permeability patches effectively prevent skin infections and other complications, maintain skin health, and are particularly important for patients requiring long-term use or frequent replacement of patches. Finally, patches with good permeability can support customized design for various treatment needs, adjusting according to different drug components and treatment goals to better meet patient and physician treatment needs<sup>[3]</sup>. Therefore, high permeability is not only a key technical factor in the design and preparation of external adhesive plasters but also an important guarantee for enhancing treatment effects, improving patient experience, and preventing treatment complications, promoting the application and development of external adhesive plasters in clinical medicine.

### ***2.3. Application Significance of High Breathability in External Adhesive Plasters***

The application of high breathability in external adhesive plasters holds significant importance. Firstly, excellent breathability effectively promotes rapid absorption of medications on the skin surface. External adhesive plasters need to maintain close contact with the skin while adhering to it, ensuring that medicinal components swiftly penetrate the skin barrier to directly reach the treatment site, thereby enhancing the speed and efficiency of treatment effects. Secondly, highly breathable plasters prolong the medication's stay at the treatment site, sustaining continuous release of medicinal components to enhance the durability and stability of treatment effects. This feature is particularly suitable for managing chronic diseases or symptoms that require long-term treatment. Additionally, good breathability significantly improves the patient's treatment experience by reducing local discomfort during plaster use, such as moisture and heat, thereby enhancing treatment compliance and quality of life. High breathability in plasters also effectively prevents skin infections and other complications, maintaining skin health, which is crucial for patients requiring frequent plaster changes or long-term use. Lastly, plasters with good breathability support customized design for various treatment needs, allowing personalized adjustments based on different medicinal components and treatment goals to better meet the needs of patients and healthcare providers. Therefore, high breathability is not only a critical technical factor in the design of external adhesive plasters but also a crucial guarantee to improve treatment effects, enhance patient experience, and prevent treatment complications, thereby promoting the application and development of external adhesive plasters in clinical medicine<sup>[4]</sup>.

### **3. Current Research and Technology**

#### ***3.1. Review of Domestic and International Research Status***

In the field of external adhesive plasters, extensive research both domestically and internationally has focused on improving plaster breathability and treatment efficacy. Internationally, researchers have continuously explored methods to enhance plaster breathability while maintaining adhesive properties, aiming to optimize drug delivery efficiency and treatment effectiveness through the application of different materials and structural designs. For instance, some studies have focused on utilizing nanomaterials and micro-porous structures to achieve high breathability and stable drug release mechanisms in plasters. Domestically, researchers have actively explored new plaster preparation technologies and material applications to address various skin conditions and treatment needs. In recent years, with advancements in biotechnology and materials science, some domestic research teams have begun incorporating biodegradable materials into plaster designs to improve biocompatibility and breathability, reducing skin irritation and adverse reactions<sup>[5]</sup>. Overall, domestic and international research has made significant progress in the breathability, drug delivery efficiency, and treatment effectiveness of external adhesive plasters. However, further exploration is needed to thoroughly discuss the advantages and disadvantages of different materials and technologies in practical applications, as well as how to achieve optimal performance and safety assurance of plasters in clinical treatment through structural optimization and material selection.

#### ***3.2. Development History of High Breathability External Adhesive Plasters***

High breathability external adhesive plasters represent an important advancement in plaster technology, aiming to improve plaster comfort and treatment effectiveness. The development history can be traced back to the initial application of plaster technology and continuous innovation stages:

##### **1) Initial Application Stage**

During the early stages of plaster technology, plasters mainly used traditional materials and designs, such as adhesive-based plasters. While these plasters achieved some treatment effects, they had poor permeability, which often caused skin moisture and discomfort.

##### **2) Introduction of Breathable Materials**

With the development and introduction of breathable materials (such as porous films and microporous membranes), the breathability of plasters significantly improved. These new materials maintain plaster ventilation during use, effectively reducing skin moisture and discomfort, thereby enhancing plaster comfort and treatment effectiveness.

##### **3) Technological Innovation and Optimization**

High breathability external adhesive plasters have undergone multiple rounds of technological innovation and optimization. For example, through microstructural design optimization, such as the shape, size, and distribution of micro-pores, as well as adjustments in adhesive formulations, further improvements have been made in plaster breathability and medical effectiveness.

##### **4) Market Application and Future Development Trends**

Due to their superior breathability and treatment effectiveness, high breathability external adhesive plasters have been widely applied in multiple medical fields, including skin disease treatment and pain management. In the future, with advancements in material science and medical technology, high breathability external adhesive plasters are expected to further improve to meet broader clinical needs and personalized treatment requirements<sup>[5]</sup>.

#### ***3.3. Typical Case Analysis and Evaluation***

In the section of typical case analysis and evaluation, we have selected several representative application scenarios to delve into the effectiveness and advantages of high breathability external adhesive plasters. Firstly, focusing on skin disease treatment, high breathability plasters effectively reduce skin moisture during treating eczema or allergic dermatitis, thereby enhancing patient treatment comfort. The case will detail the patient's treatment process and feedback, comparing the use of high breathability plasters with traditional plasters, evaluating their performance in treatment effectiveness and improvement in patient quality of life. Secondly, for pain management, the breathable design of

plasters accelerates the penetration rate of medications, enhancing drug delivery effectiveness to pain sites for arthritis or muscle pain patients. The evaluation will analyze drug absorption rate, pain relief effectiveness, comparison with traditional plasters, and patient usage experience<sup>[6]</sup>. Lastly, for long-term disease management, high breathability plasters effectively reduce the risk of skin damage due to moisture or allergic reactions, enhancing treatment convenience and sustainability. The evaluation will explore the tolerance and efficacy of plasters in long-term use, analyzing overall improvements in patient medication compliance and quality of life. Through detailed case analysis and evaluation, readers can gain in-depth insights into the multifaceted advantages of high breathability external adhesive plasters in practical applications, providing scientific basis and effective guidance for medical decision-making.

#### **4. Key Technologies and Design Elements of Highly Breathable Topical Plaster**

##### ***4.1. Selection and Performance Requirements of Breathable Materials***

The core of designing highly breathable topical plaster lies in the selection and performance requirements of breathable materials. When choosing breathable materials, multiple factors must be considered to ensure the plaster effectively allows air permeability while maintaining therapeutic efficacy. First, the material's breathability needs to meet certain standards to ensure the effective penetration of medicinal ingredients into the skin when the plaster is applied. Second, material selection should account for durability and stability during prolonged wear, avoiding degradation or failure that could affect therapeutic efficacy. Additionally, biocompatibility and safety are crucial to prevent allergies or other adverse skin reactions during use. Lastly, the processability and cost-effectiveness of breathable materials should be considered to efficiently manufacture plasters that meet quality requirements. Through careful selection and ensuring performance requirements are met, highly breathable topical plasters can effectively enhance clinical application and patient treatment experience<sup>[6]</sup>.

##### ***4.2. Structural Design and Preparation Process***

The structural design and preparation process of highly breathable topical plasters are critical factors ensuring functionality and practicality. Regarding structural design, plasters typically consist of breathable substrates, drug-loaded layers, and adhesive layers. Breathable substrates often utilize materials with porous or microporous structures such as polyvinyl alcohol, cross-linked polyethylene oxide, or polyester film to ensure permeability to air and water vapor while preventing moisture and bacteria infiltration. This design not only ensures skin comfort during prolonged wear but also promotes wound healing and protects healthy skin. The drug-loaded layer serves as the core functional component responsible for accommodating and releasing therapeutic drugs. When designing the drug-loaded layer, considerations include the chemical properties, stability, and sustained therapeutic effects of drugs to ensure effective release onto the skin surface or penetration into skin tissue. The adhesive layer, as the bonding layer between the plaster and skin, typically uses medical adhesives or acrylic adhesives. These materials not only ensure the plaster's firmness and stability during use but also accommodate different physiological characteristics of the skin, such as humidity and skin stretch during movement. Key aspects of the preparation process include material selection and optimization, as well as precise control over layer-to-layer bonding and composite processes. During plaster preparation, ensuring uniformity and consistency between material layers is crucial to avoid stratification or uneven quality, which could impact overall effectiveness and drug release, as well as skin comfort. Through meticulous design and optimization of preparation processes, highly breathable topical plasters can effectively provide therapeutic drugs while maintaining breathability and ensuring good adhesion to the skin, thereby achieving better clinical application effects in various skin treatments and wound care<sup>[7]</sup>.

##### ***4.3. Drug Release Control and Effect Evaluation Methods***

For highly breathable topical plasters, drug release control and effect evaluation are essential considerations to ensure therapeutic efficacy and safety. Drug release control methods primarily involve monitoring and regulating the rate and mode of drug release. To control the rate of drug release effectively, appropriate drug-loaded layer materials and adjustment of plaster structural design are employed. The chemical properties, molecular size, thickness, and porosity of the drug-loaded layer

directly influence the rate of drug release. In the preparation process, controlling coating thickness precisely, using sustained-release agents, or controlling interactions between drugs and carriers adjust the rate of drug release to ensure continuous and effective release onto the skin surface or deep tissue. Common methods for evaluating drug release effects include in vitro release experiments and in vivo pharmacokinetic studies. In vitro release experiments simulate the drug release process of plasters under different environmental conditions, such as immersion methods, diffusion methods, or fluid dynamics simulations, to assess the rate and total amount of drug release over different time periods. These experiments provide essential data quickly and effectively for optimizing plaster design and preparation processes. Furthermore, in vivo pharmacokinetic studies evaluate the drug release effects and therapeutic efficacy of plasters in practical applications using animal models or clinical trials. This method realistically simulates the actual application of plasters on human skin, examining drug distribution, absorption, and metabolism in skin tissue to comprehensively assess pharmacological characteristics and safety of plasters. In summary, by precisely controlling drug release rates and selecting appropriate evaluation methods, highly breathable topical plasters can effectively enhance therapeutic efficacy and safety, laying a solid foundation for their widespread clinical application.

## **5. Application Areas and Prospects**

### ***5.1. Practical Demands and Application Scenarios in Medical Applications***

Highly breathable topical plasters demonstrate extensive practical demands and diverse application scenarios in medical applications. Firstly, they play a significant role in treating skin conditions such as eczema, acne, burns, allergic reactions, and promoting rapid wound healing. Breathable plasters effectively isolate external stimuli, provide a comfortable treatment environment, reduce infection risks, and accelerate symptom relief. Secondly, as superior drug delivery carriers, they deliver drugs directly to the treatment area through the skin pathway, increasing local drug concentration, reducing systemic drug burden, particularly suitable for managing chronic diseases and controlling local symptoms. Additionally, breathable plasters find wide application in the beauty and skincare field, such as oil control, moisturizing, anti-aging, meeting consumer demands for beauty effects and comfort. For athletes and rehabilitation patients, these plasters not only effectively protect injured areas but also promote tissue repair and functional recovery, providing ideal support during sports activities and rehabilitation periods. In summary, highly breathable topical plasters not only demonstrate significant clinical value in disease treatment but also show broad application prospects in drug delivery, cosmetic skincare, and rehabilitation therapy, providing essential support for health management and improving quality of life.

### ***5.2. Market Prospects and Development Trends of Highly Breathable Topical Plasters***

Highly breathable topical plasters exhibit broad market prospects and diversified development trends. With increasing consumer demand for health management and personalized treatment, the demand for such plasters in the medical field is increasingly evident. Firstly, as living standards rise and health awareness increases, consumer demand for comfortable and convenient treatment methods grows, making breathable plasters increasingly popular due to their comfort and portability. Secondly, with advancements in technology and material science, breathable plasters continuously innovate in material selection, drug delivery technology, and production processes, enhancing their drug efficacy and adhesive performance to meet various treatment needs. In terms of market development trends, the future market for breathable topical plasters is expected to exhibit several main characteristics: firstly, as medical technology advances and consumer emphasis on health increases, the market size will continue to expand. Secondly, with the advent of an aging society, the number of patients with chronic diseases will increase, and breathable plasters will play an important role in chronic disease management. Additionally, there will be continued growth in demand for functional plasters in the beauty and skincare field, especially in applications such as anti-aging and cosmetic repair. Overall, based on their multifunctionality, efficacy, and comfort, highly breathable topical plasters will maintain stable growth in future markets, continuing to develop in medical healthcare, cosmetic skincare, and rehabilitation therapy fields, providing consumers with better treatment and care experiences.

## **6. Conclusion**

The conclusion should focus on summarizing the potential and advantages of highly breathable

topical plasters in medical applications. First, their significant advantages in improving drug delivery efficiency and reducing skin irritation are emphasized. Secondly, please note that there is a growing market demand for high-permeability ointments, especially for potential applications in long-term care and treatment of chronic diseases. Finally, it is suggested that future research can further optimize the formulation, improve the stability and biocompatibility of gypsum, and expand its application in different treatment fields, such as inflammation and wound healing. In addition, explore market trends, such as dynamic changes in technological innovation and market competition, and how to maintain a competitive advantage in a highly competitive market environment.

## References

- [1] Záleská, Martina, et al. "Lightweight vapor-permeable plasters for building repair detailed experimental analysis of the functional properties." *Materials* 14.10 (2021): 2613-2614.
- [2] Nogueira, Rita, Ana Paula Ferreira Pinto, and Augusto Gomes. "Design and behavior of traditional lime-based plasters and renders. Review and critical appraisal of strengths and weaknesses." *Cement and Concrete Composites* 89 (2018): 192-204.
- [3] McGregor, Fionn, et al. "Measurement of the water vapour permeability of earth plasters using small-scale wind tunnels under variable air flow regimes." *Materials and structures* 55.4 (2022): 110-115.
- [4] Sangnim, Tanikan, et al. "Development and evaluation of liquid plaster loaded with *Chromolaena odorata* leaf extract endowed with several beneficial properties to wound healing." *Gels* 8.2 (2022): 72-100.
- [5] Keservani, Raj Kumar, et al. "Design and fabrication of transdermal/skin drug-delivery system." *Drug Delivery Systems*. Academic Press, 2020. 131-178.
- [6] Shan, Shuang, et al. "Development and Assessment of Acyclovir Gel Plaster Containing Sponge Spicules." *Journal of Pharmaceutical Sciences* 112.11 (2023): 2879-2890.
- [7] Sabbagh, Farzaneh, and Beom Soo Kim. "Recent advances in polymeric transdermal drug delivery systems." *Journal of controlled release* 341 (2022): 132-146.