

## Topical and Transdermal Applications of Solid Lipid Nanoparticles

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### Abstract

Solid lipid nanoparticles (SLN) are emerging as efficient as possible nanocarriers with special physicochemical characteristics for topical, in addition to transdermal, medication delivery, biocompatibility, as well as being able to boost skin penetration. SLNs are made of solid lipids stabilised by surfactants and stay solid at both atmospheric and human body temperatures, giving controlled release of medications, improved drug stability, and protection of labile compounds. This chapter presents a comprehensive overview of the fundamentals, design principles, and therapeutic applications of SLNs in dermal drug delivery systems. This chapter begins with the basic principles and historical development of SLNs, discussing their composition, mechanisms of drug encapsulation, and comparison with other colloidal carriers like liposomes and nanostructured lipid carriers (NLCs). There is a thorough examination of important physicochemical properties, including stability, the loading of drugs, zeta potential, along with size of particles. Various formulation strategies and

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production methods, including high-pressure homogenization, microemulsion techniques, and solvent evaporation, are reviewed, alongside optimisation tools like Quality by Design (QbD). Topical applications of SLNs in dermatology and cosmetics highlight their benefits in treating conditions such as acne, psoriasis, and skin ageing, while transdermal applications focus on systemic delivery of drugs like Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) and hormones. The review also discusses evaluation methodologies, regulatory challenges, and potential toxicity concerns. Recent innovations, including stimuli-responsive and microneedle-assisted SLNs, are highlighted to showcase future directions. Overall, SLNs represent a versatile platform for safe and effective dermal drug delivery, offering promising potential in both clinical and cosmetic fields.

**Keywords:** Biocompatibility, Controlled Drug Release, Dermatological Applications, Drug Encapsulation, Formulation Techniques, Microneedle Assisted Delivery, Physicochemical Properties, Skin Permeation Enhancement, Stimuli-Responsive Nanocarriers, Topical Drug Delivery, Transdermal Delivery.

## 1. INTRODUCTION

Topical as well as transdermal medication systems for delivery are the two key methods in contemporary pharmaceutical sciences that exploit the skin as an avenue of administration of drugs. All these processes work through the element of percutaneous absorption, the only difference being the purpose of the action, penetration and therapeutic effects. Topical agents deal with local treatment and have restricted the medication transport within the skin's outermost layers, especially the dermis and epidermis, which include eczema, fungal infections, and psoriasis. It regularly utilises creams, ointments, lotions and gels. It has the advantages of having few systemic side effects, as cheating the first stage of metabolism is simple to give, yet is effective. Being hindered by a lack of penetration and skin variability [1-2].

Conversely, transdermal medication administration was developed to administer medications where systematic absorption takes place, meaning that the pharmaceuticals deeply penetrate the dermis thus are absorbed via the system of circulation. It might deliver it with a