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Transdermal Drug Delivery: Beyond the State of the Art

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Topical remedies, such as creams, gels, ointments and bandages, rubbed or applied to the skin, have been used over centuries. Being the largest organ in the body (1.5 – 2 m^2 in adults), skin can be a good candidate for drug administration. Administration of therapeutic agents across the skin enables drugs to avoid p.o. first-pass chemical or enzymatic degradation in the gastrointestinal tract or liver.

However, the outermost layer of skin, *stratum corneum* (15 – 20 µm thick), which protects the human body from toxic chemicals, makes it challenging for high molecular weight and hydrophilic molecules to pass passively through this membrane

To address this limitation, different methods have been investigated to enhance the permeability of the *stratum corneum*. On the one hand, the design of chemical formulations with chemical skin enhancers such as solvents and surfactants as well as the synthesis of co-drug modified therapeutics to disrupt the structure of the *stratum corneum* have been proposed. On the other hand, physical techniques including mechanical and thermal approaches have been used to generate micrometer disruptions in the *stratum corneum* structure. Another interesting strategy is based on the use of microneedles filled with drugs to pierce the *stratum corneum* and enhance drug permeation. Other studies have shown that heat can be used as an external trigger to increase skin permeability, thus facilitating transdermal drug delivery.

In this presentation, I will discuss our results on the use of thermal activation to enhance skin permeation. To this end, we demonstrated the potential of photothermal active graphene-based patches to enhance skin permeation. The choice of graphene is made based on its various benefits such as strong absorption in the near infrared (NIR), rapid light-to-heat conversion under low-power NIR irradiation, high loading capacity, ease of functionalization and facile solution phase processing. Moreover, graphene offers the possibility to prepare countless number of multifunctional nanocomposites or nanohybrids through incorporation/assembling of

functional building blocks, opening new avenues for delivery of various therapeutics. The use of NIR irradiation is very advantageous as most of biological molecules are transparent to this irradiation, thus limiting their inactivation/denaturation.