



Bōshi Beauty<sup>Inc.</sup>

# FORMULATING WITH NANOFIBERS

Learn the benefits of Nanofibers in skincare formulas and how they differ from traditional skincare formulations—providing a waterless, effective solution.

 TaikiUSA



## FORMULATION

When it comes to formulating traditional skin care products, such as creams, lotions and serums, not much has changed over the past few decades. They are typically formulated using primarily well-known ingredients with a few functional ingredients at low concentrations.

In order to ensure stability throughout the duration of their shelf-life, additives are included to prevent phase separation, discoloration, odors, reduced activity of functional ingredients and microbial growth. Most formulations contain a high amount of water also.

# FORMULATION BARRIERS

Many limits exist on what can be used in a traditional aqueous format. Certain ingredients may not be stable in aqueous solutions, often degrading over time, resulting in a significant loss of efficacy.

In some cases, there may be a combination of ingredients that is desirable for a specific application, but there are limitations due to incompatible solvent systems or reactions that can occur over time between the ingredients. Many skin care routines require multiple steps for this reason. It is not possible to formulate one product that contains a wide variety of functional ingredients, each with its own requirements for pH, solubility, and viscosity. Or is it?





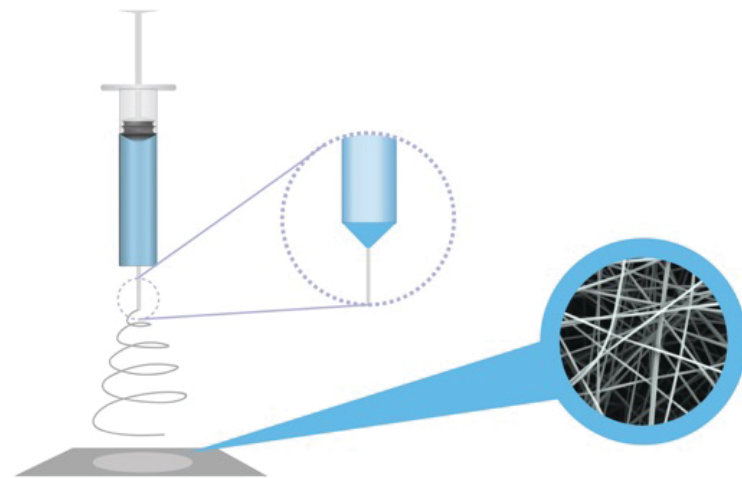
# ELECTROSPUN NANOFIBERS

**Electrospinning has been around for over a century, but much of the research on the properties and potential uses of electrospun nanofibers has been conducted during the past three decades<sup>1</sup>.**

The filtration industry was the first to recognize the benefits of having fibers with a diameter of 1/1,000,000,000th of a meter; a filter with a nanofiber layer could physically trap even the smallest of particles, resulting in very high efficiency filtration<sup>2</sup>. Nanofibers have also found uses in the biomedical industry as they mimic the extracellular matrix and can be made from biocompatible materials that will degrade over time, allowing a body's own cells to grow on the nanofiber scaffold<sup>3</sup>.



**As with many new technologies, electrospun nanofibers continue to find new uses in a variety of industries. Only recently has the cosmetic industry taken notice of the potential that nanofibers have for innovative new products, particularly those related to skin care.**



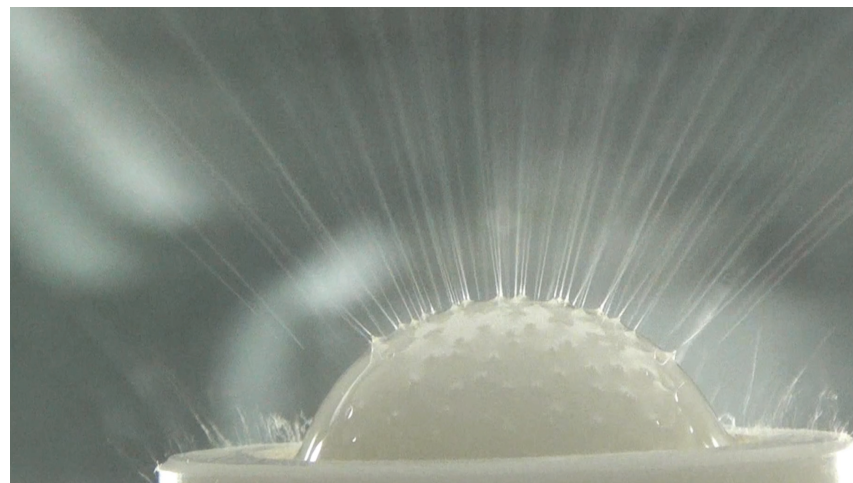
**Needle Spinning - Initiated in the early 1900's**



## NANOFIBER VS. TRADITIONAL PRODUCTS

One of the main differences when it comes to nanofiber products vs. traditional cosmetics is the dry format of the nanofiber.

With a lotion or cream, you may need to add emulsion stabilizers to ensure that you don't have phase separation. Rheology modifiers may be necessary to achieve the proper viscosity required for application. Neither is necessary in the case of nanofiber products. Functional ingredients, or actives, can be added directly to the polymer solution and electrospun.



The solvent, water in this case, evaporates during the process leaving behind the dry nonwoven nanofiber sheet with the actives incorporated throughout. Other additives can be included if desired but are not typically necessary.



# STABILITY OF ACTIVES

**Another concern that often comes up with traditional cosmetic formulations is the stability of the active ingredients.**

Different methods are employed to keep the active from having a reduction in efficacy over time. Nanofibers have actually been explored as an alternative to freeze drying as a result of their ability to stabilize compounds; Golpira et al. compared the degradation kinetics of bioactive compounds from saffron when encapsulated into a gelatin matrix either by electrospinning or freeze drying.

It was determined that “electrospinning was a better and more effective technique than freeze drying in terms of preserving saffron bioactive compounds.”<sup>4</sup>



# BŌSHI BENEFITS

As mentioned, Bōshi fiber products are essentially waterless, which results in extremely low water activity, in the range of 0.38-0.62, depending on the formulation.

Water activity is an indication of self-preservation, as all microorganisms require water and nutrients for proliferation. For reduced risk of microbial growth, water activity should be below  $a_w = 0.75$ <sup>5</sup>. As a result, Bōshi products may not require a preservative.



**SAFE**



**PRESERVATIVE-FREE**



**WATERLESS**

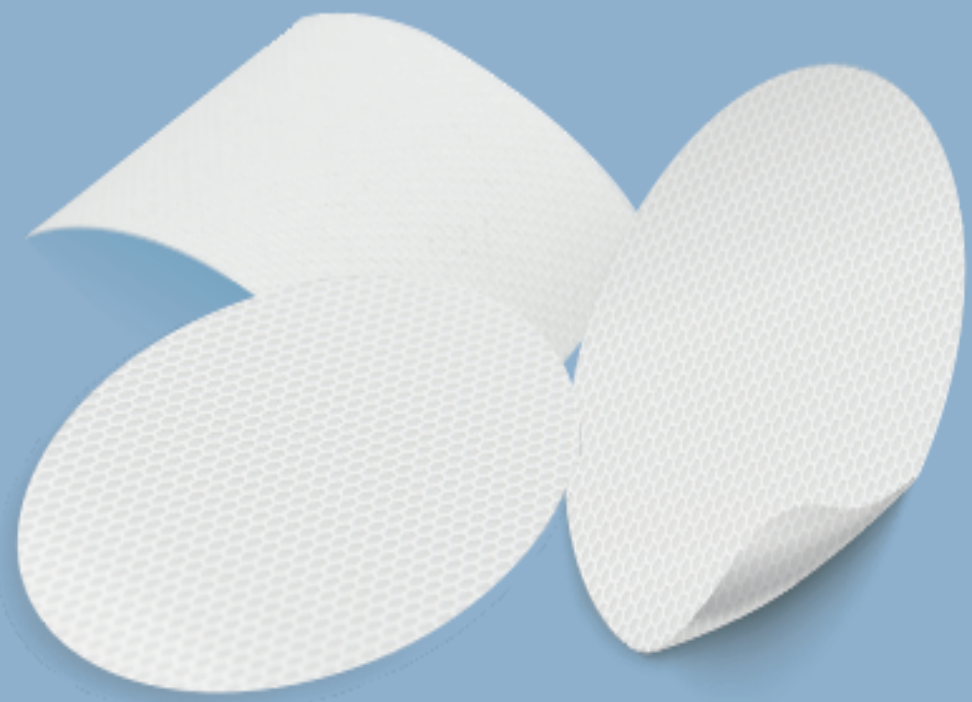
Given that so much of what normally goes into a traditional cosmetic formulation can be left out of the nanofiber formulation, the concentration of active will not be what is suggested by the ingredient supplier. When the product contains only the polymer nanofibers and the actives, the result is that Bōshi products are much lighter than traditional skincare, so the concentration of the active will necessarily be higher in order to achieve the same dose. It is a straightforward calculation, but something to keep in mind when formulating with nanofibers.



## VERSATILE DELIVERY SYSTEMS

**Although in some cases creating a very simple formula with just a few ingredients is desirable, one of the other benefits of formulating with nanofibers is actually the ability to produce more complex formulas.**

In this case though, the complexity is not a result of adding compounds to preserve or stabilize the formulation. With Bōshi nanofiber technology, you can formulate products that contain incompatible ingredients. As mentioned previously, the polymer nanofibers are collected as a sheet. These sheets can be layered to produce dissolvable nanosheets, with each layer containing a different functional ingredient. So rather than finding a common solvent or having a 2-part delivery system, you can simply electrospin the ingredients separately. The dry nanofiber sheets can then be layered and each ingredient can remain isolated until the product is dissolved, just prior to application.



## MULTI-FUNCTIONAL FORMULAS

**Similarly, multi-functional ingredients can be incorporated into the nanofibers. In addition to combining multiple sheets of nanofibers, you can also sandwich solid functional ingredients in between the layers of nanofiber.**

This could be a powder, such as microcrystalline cellulose, gelled oil beads, or Vitamin C. As a result, you can incorporate a wide variety of materials into Bōshi fibers.

Ingredients that are water soluble can be added directly to the spinning solution, as can non-water-soluble particles that are very fine. Larger non-water-soluble particles or any hard to disperse particles can be entrapped between layers of fibers.

This flexibility provides a perfect opportunity for formulators to create new and innovative products that were not possible with traditional cosmetic formulation technology.

# LIQUID FORMULATIONS

So that covers dry powders of differing compositions, but what about liquids?

Even though the polymer solution used for cosmetic applications is typically water soluble, it is also possible to infuse the Bōshi fibers with oils. This can be done as a secondary process or as part of the spinning process. With the secondary process, the oil will be added to the dry nanofiber, which will allow for the nanofiber patch to adhere to the skin prior to wetting with water. This can be seen in the 3-in-1 cleansing and moisturizing patch that was developed using Bōshi fiber technology.





# A NEW APPROACH



**It has been a long time since there has been a disruptive technology such as this in the skin care space. It is easy to envision the vast number of possibilities that exist for new product formulations using the Bōshi fiber technology.**

**Whether your goal is to simplify formulas by reducing the number of ingredients or simplify your skin care routine by making multi-functional materials, formulating with nanofibers can help you achieve your goals.**

## **SOURCES**

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