

Ultrasound gels – effects, compositions, applications

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Ultrasound applications have found their way into the standard repertoire of cosmetic treatments. What is the role of ultrasound gels in this context?

The human ear is able to hear sounds with frequencies from about 20 Hz to 20 kHz provided that they are intense enough. The term ultrasound refers to sound waves beyond the perceptive faculty of the human ear within the frequency range of 20 kHz to 1 GHz.

It all depends on physics

The intensity of sound waves is measured in Watt per cm² and specifies the energetic content of the waves. While absorbed in the tissue the sound waves are also modified into thermal energy which may cause an increase of temperature. Closely related to the energy of ultrasound waves is the sound pressure: the sound wave periodically generates low pressure and high pressure. Very low pressure may cause gas bubbles (cavitation) in the tissue and subsequently also lead to tissue damage. That is the reason why threshold values have been set up for the sound pressure which is measured in Pa (Pascal). Sound pressures for diagnostic applications in the tissue usually are below 0.5 MPa.

Low frequency ultrasound waves penetrate deeper into the tissue whereas high frequency ultrasound waves permeate the superficial layers. Therapeutic applications with emphasis on thermal and mechanical effects preferably have frequencies between 20 and 800 KHz while diagnostic applications use frequencies between 1 and 40 MHz. Cosmetic treatments also apply frequencies in the MHz range. Ultrasonic heads for cosmetic applications cover areas of one up to several cm². The focus here also is on mechanical and thermal effects combined with an increased circulation and the stimulation of metabolic processes. The cellulite treatment concentrates above all on mobilizing the fat deposits.

Ultrasonic media

In order to avoid intense sound reflections at the borderlines between ultrasonic head and skin resulting from air pockets, it is necessary to use ultrasonic media. They provide the optimal contact between ultrasonic head and skin. Ul-

trasonic media must be absolutely free of air bubbles in order to ensure the perfect sound transmission. Liquids like water and alcohols basically are suitable media however rather inappropriate with regard to their volatility and low viscosity. That is why specific gels have been developed.

As a matter of fact, gels are liquids that contain thickening agents to improve their spreadability on the skin. A distinction is made between hydrogels and lipogels (oleogels). Lipogels consist of vegetable, synthetic or mineral oils. They are less appropriate as they fatten the skin and are hard to remove after the treatment. The main component of hydrogels is water as the term already implies. That is the reason why hydrogels can be easily removed after the treatment without leaving any residues. Even if carelessly handled they will not stain the clothing.

Crucial point is preservation

A basic advantage of gels is their gliding property, i.e. the ultrasonic head subtly glides over the skin. Since water-based ultrasound gels for health care purposes are produced in high quantities and consist of more than 90 per cent of water, they are rather inexpensive and may be ordered in small quantities up to can size economy packs. Internet platforms often discuss how to tell the difference between these gels and expensive gliding gels used for the genital area as their characteristics as well as their composition is identical at least with regard to their outward appearance.

Ultrasound gels used for diagnostic purposes are formulated for a short stay on the skin and hence belong to the group of medical products with "rinse off characteristics". Due to their high water content they require adequate preservation which almost exclusively is achieved with highly effective preservatives like methyl dibromo glutaronitrile or abbreviated MDGN (1,2-Dibromo-2,4-dicyanobutane). Since its introduction MDGN has developed into one of the strongest contact allergens. Therefore it has been down-rated for the use in "rinse off products" in the Cosmetic Decree (KVO) which

is not applicable for medical products though, and in 2007 it was completely removed from the list of allowed preservatives. These compounds are inappropriate as gliding gels for both non medical applications and cosmetic treatments because they are actually used as "leave on products".

Besides MDGN also a mixture of methyl isothiazolinone and chloromethyl isothiazolinone (kathon) may be included with analogous phenomena. Gels containing the above mentioned preservatives frequently also include phenoxy ethanol, benzyl alcohol and parabens as preserving agents and that is the reason why they are an unacceptable allergy potential for cosmetic ultrasound treatments. Product descriptions like "without formaldehydes" or "non-irritant" in this context suggest a false sense of product safety.

It can be assumed that over-the-counter medical gels are also used in cosmetic institutes as the gels sold by manufacturers of ultrasonic devices generally are more expensive. Even in this case it is recommended to take a closer look at the INCI. Experience has shown that the central problem consists in the fact that the ultrasound treatment is used to transport active agents into the skin. As a result the ultrasound gel is supposed to act as a

- contact gel for sound transmission
- carrier for cosmetic agents
- medium to release cosmetic agents
- skin caring substance.

If hydrogels are preserved in the above mentioned way, these substances are also penetrated deeply into the skin.

Cosmetic gels

Thickening and gliding characteristics of the hydrogels are achieved exclusively by adding carbomers and their derivatives. Carbomers are polymers of the acrylic acid (polyacrylates) whose salts can bind enormous amounts of water. Sodium salts are listed in the INCI as sodium carbomer or carbomer and sodium hydroxide. On first sight the content of sodium hydroxide insinuates that a health risk may be associated with the application, however, it is only used as a neutralizing agent in the manufacturing process and no longer present in the ready made gel.

Due to their chain length (high molecular weight) carbomers are not absorbed by the skin. Residues on the skin surface even have a caring effect due to their filming characteristics that can be improved by additives like xanthan gum, which is a biotechnologically produced polysaccharide. Xanthan gum also has thick-

ening properties and increases the gliding characteristics of the ultrasound gel. Similar to the application of hyaluronic acid xanthan has a pleasant smoothing effect on the skin and in addition, it provides an excellent moisturizing capacity. The TEWL (transepidermal water loss) will be slightly reduced if residues of the gel remain on the skin surface. Further water binding effects within the skin are achieved by adding glycerin, glycols and sugar alcohols, as for example sorbitol.

Well-tolerated

The last mentioned ingredients enable the formulation of gels that are free of preservatives and still have a long shelf life. These gels are non-allergenic, completely transparent and among other applications safe enough to use as gliding gels. They are excellent carriers for active agents in form of aqueous extracts, vitamins and sera made from mono substances like D-panthenol, hyaluronic acid, and CM-glucan. With adequate consistency the gels may even be used to disperse vegetable oils. Consequently, the oils are no longer transparent but have a milky appearance with excellent skin-caring features particularly if the oils contain essential fatty acids. The ultrasound effect however is noticeably impaired due to the interfaces between oil droplets and watery phase. Although cosmetic ultrasound treatments to some extent have mask-like functions they are frequently applied in combination with a mask. A massage is not required due to the mechanical energy of the ultrasound, although it may be taken into consideration as the ultrasound sometimes spares sensitive skin areas.

Careful with sensitive skin

If containing vegetable extracts it should be kept in mind that a multitude of different substances will penetrate through the horny layer. Sensitive skin may develop skin reactions in this specific case. Thus it is advisable to pre-treat a small area at the forearm to test the tolerance of the extract.

The ultrasound technique is a versatile treatment method. Active agents for conventional masks and massages may also be used in this context. Besides the already mentioned cellulite treatment the following indications are possible:

- **skin tightening** with hyaluronic acid and amino acids belonging to the NMF
- **anti-wrinkle treatments** with paracress extract or oligopeptides
- **skin smoothing** with aloe vera, algae, D-panthenol or linseed oil

- treatment of **sun erythema** with echinacea extract and linseed oil
- stimulating the **metabolism** with green tea, coenzyme Q10 and phyto hormones
- care of **atopic skin** with evening primrose oil
- treatment of **hyperpigmentations**
- massaging of **scars** with the vitamins A, C and E.

The surplus gel is wiped off or gently dabbed off after the treatment. A cleaning of the skin is not required.

If the ultrasound gel contains highly viscous active agent solutions *i.e. they already include a consistency agent like sodium carbomer or xanthan*, the solutions can even be used in pure form. It is not necessary to apply ultrasound treatments in order to penetrate active agents which are encapsulated in liposomes or nanoparticles. These systems as such already penetrate rather fast into the skin. If they are

still used for ultrasound applications only the applied mechanical or thermal energy will have additional therapeutic effects.

By the way: Gels enriched with active agents and xanthan may also be used for the home care of the eye and the neck area without ultrasound treatment.

Important abbreviations

Hz = Hertz; 1 Hz = 1 oscillation per second (1 s⁻¹)

kHz = Kilo-Hertz = 1000 Hz

MHz = Mega-Hertz = 1.000.000 Hz

GHz = Giga-Hertz = 1.000.000.000 Hz

Pa = Pascal

MPa = Mega-Pascal = 1.000.000 Pascal

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