WHITEPAPER

AMBIJET

1 SUMMARY

Plasma has many applications today, including in the medical field. This paper presents the development of a plasma technology to treat inflammation around dental implants.

2 BACKGROUND

Plasma is an ionized, quasi-neutral gas in which electrons are partially or completely separated from atoms or molecules. Accordingly, ions, electrons and neutral gas particles coexist in plasma. This state is achieved by supplying energy (thermal, electrical, etc.) to the gas.

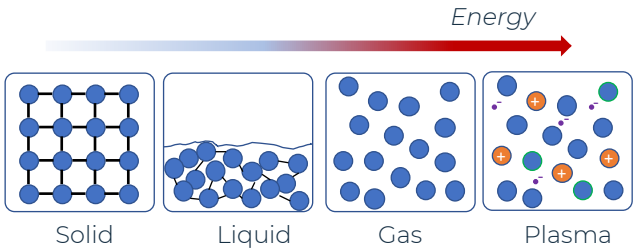

FIGURE 1. The four states of matter. The energy supplied leads to increased mobility of the elementary particles that make up the material and changes the way they bind or arrange themselves to one another.

Plasmas are multi-component systems that are highly reactive due to their high concentration of charged or excited (but neutral) particles. Each of the charged particles (positive and/or negative ions and electrons), excited atoms and molecules, and photons (of various wavelengths) plays a specific role in physical and/or chemical reactions with the materials with which the plasma is in contact.

Plasma can be generated under atmospheric pressure. When the gas in which the plasma is generated flows through a channel, the plasma forms what is called a "plasma jet" as it flows out of the nozzle.

Plasma medicine is a rapidly growing application area for atmospheric pressure plasma jets. So far, such plasmas have been used mainly in the field of sterilization of surfaces, of medical devices or for surface treatment of implants to improve their biocompatibility [1]. The elements of the plasma interact with microorganisms in specific ways (see Fig. 2). They can contribute to sterilization by inactivating, killing, or disintegrating the microorganisms in question, such as bacteria or viruses [1]. Atmospheric pressure plasmas are increasingly used in medicine by direct application. For example, in the field of wound healing, where the treatment of chronic wounds is carried out directly with a plasma, in various skin diseases, or even in new approaches such as cancer therapy [2].

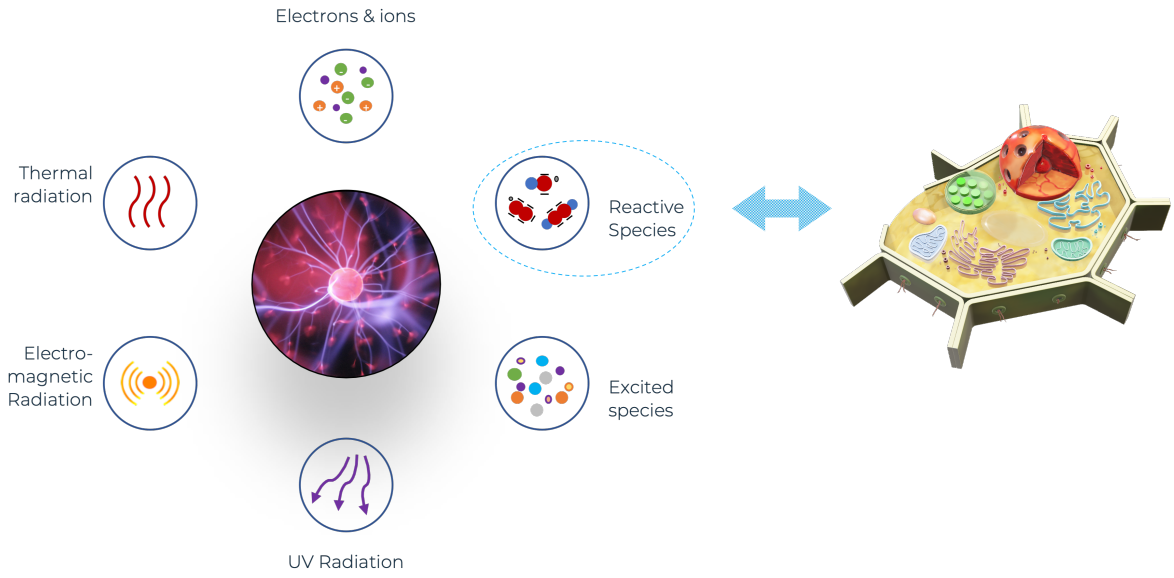

FIGURE 2. Complex interactions between plasma and biological system [3].

3 TECHNOLOGY

Plasma can be electrically excited from direct current to microwaves. It can be pulsed simultaneously and thus operated at mixed frequencies. Frequency, voltage and current must be matched to the type of gas and gas flow to produce the desired particles that will have the desired effect on the desired target microorganism, but without causing side effects (e.g. excessive heating).

Freiburger Medizintechnik GmbH designed and developed the plasma-based "AmbiJet" system from the ground up for use in dentistry (see Fig. 4). The system consists of a base unit with integrated gas cartridge and handpiece as well as single-use applicators. The design of the handpiece and applicator is based on the ergonomics of standard dental instruments.

The specially developed electronics generate an extremely effective plasma between the applicator and the targeted surface. Thanks to clever engineering, the plasma is guided from the applicator to the targeted surface. This plasma jet device not only meets the elemental disinfection requirement, but also ensures a high level of safety for the patient and the operator. At every step of the development, we took the ISO standards for medical electrical equipment and specific standards into account.

FIGURE 3. LEFT: base station with gas cartridge and handpiece. RIGHT: the applicators: periSlide and inDrive.

4 APPLICATIONS

AmbiJet kills bacteria highly efficiently, non-specifically, reduces the likelihood of reinfection, thus helping regenerative measures and promoting healing.

Thanks to the two applicators, AmbiJet can be used for both surgical (with *inDrive*) and conservative (with *periSlide*) treatments. *periSlide* features a flexible film micro-nozzle just 300 µm thick, which the practitioner slides between inflamed gums and the dental implant without having to proceed surgically. The special technology developed by the team is currently the only way to generate a plasma in a flat and flexible nozzle in the submillimeter range.

AmbiJet has been designed as a platform technology. This allows to extend the range of applications beyond periimplantitis: AmbiJet can be used for periodontitis treatments and root canal treatments, and even outside the field of dentistry.

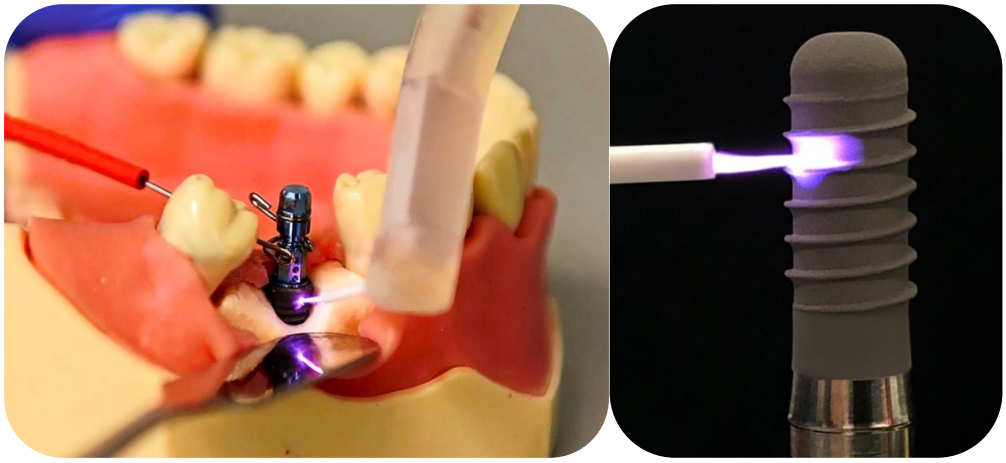

FIGURE 4. Applications of AmbiJet on dental implants.

5 UNIQUE ADVANTAGES

AmbiJet comes with a compelling list of unique selling points:

- Highest disinfection efficacy,
- First method of controlling reinfection,
- Fast treatment,
- Safe treatment,
- Painless treatment,
- Applicable for all dental implants,
- Applicable in nearly all clinical situations,
- No chemical substances,
- No need for antibiotics,
- No need for pharmacological agents,
- Easy to use technology,
- No need for intensive schooling,
- Can be delegated to assistants,
- Platform technology.

6 REFERENCES

[1] Ledernez L, Engesser F, Altenburger M, Urban G, Bergmann M, “Effect of Transient Spark Disinfection on Various Endodontics Relevant Bacteria”, Plasma Medicine, 2019.

[2] Ledernez L, Bruch R, Altenburger M, Bergmann M, Urban G, “Transient Spark for Bacterial Cleaning of Dental Microcavities”, Plasma Medicine, 2019.