Abstracts

Koban I, Matthes R, Hübner NO, Welk A, Meisel P, Holtfreter B, Sietmann R, Kindel E, Weltmann KD, Kramer A, Kocher T (2010). Treatment of Candida albicans biofilms with low temperature plasma induced by dielectric barrier discharge and atmospheric pressure plasma jet. New Journal of Physics 12:073039.

Because of some disadvantages of chemical disinfection in dental practice (especially denture cleaning), we investigated the effects of physical methods on *Candida albicans* biofilms. For this purpose, the antifungal efficacy of three different low-temperature plasma devices (an atmospheric pressure plasma jet and two different dielectric barrier discharges (DBDs)) on *Candida albicans* biofilms grown on titanium discs *in vitro* was investigated. As positive treatment controls, we used 0.1% chlorhexidine digluconate (CHX) and 0.6% sodium hypochlorite (NaOCl). The corresponding gas streams without plasma ignition served as negative treatment controls. The efficacy of the plasma treatment was determined evaluating the number of colony-forming units (CFU) recovered from titanium discs. The plasma treatment reduced the CFU significantly compared to chemical disinfectants. While 10 min CHX or NaOCl exposure led to a CFU $\log_{10}$ reduction factor of 1.5, the $\log_{10}$ reduction factor of DBD plasma was up to 5. In conclusion, the use of low-temperature plasma is a promising physical alternative to chemical antiseptics for dental practice.

Koban I, Duske K, Jablonowski L, Schröder K, Nebe B, Sietmann R, Weltmann KD, Hübner NO, Kramer A, Kocher T (2011). Atmospheric Plasma Enhances Wettability and Osteoblast Spreading on Dentin In Vitro: Proof-of-Principle. Plasma Processes and Polymers 8(10):975-982.

The medical background of these investigations is periodontal disease which involves progressive loss of the connective tissue and alveolar bone around the teeth. Increased wettability of dentin or bone replacement materials (hydroxyapatite) may be supportive for successful periodontal regeneration. In this in vitro study, we investigated if an atmospheric pressure, non-thermal plasma process is able to enhance wettability of dentin and hydroxyapatite as well as if increased wettability translates into a higher spreading capacity of osteoblasts. Surface modification was performed with an atmospheric pressure plasma jet on hydroxyapatite, mammoth ivory and human dentin discs. We used three different plasma gas compositions (argon/+0.2%oxygen/+1% oxygen) with 30, 60 or 120□s application time. Water contact angles and cell spreading of MG-63 osteoblasts were measured before and after plasma treatment. Contact angles of the three investigated materials (dentin, hydroxyapatite and mammoth ivory: 52.00°, 36.00° and 71.00°, respectively) were significantly reduced after 120□s plasma application (13.90°±1.70, 0.00°±0.00 and 0.00°±0.00, respectively). The most effective contact angle reduction was observed after 60 or 120s application of Ar+1%O_2 plasma. The cell area of osteoblasts grown on dentin treated with Ar+1%O_2 plasma was larger than on untreated dentin surfaces (p <0.05). The application of atmospheric plasma reduces the contact angle; the altered surface chemistry translates into a superior spreading of osteoblasts on dentin. These results may offer an additional approach to optimise periodontal regeneration.

Koban I, Holtfreter B, Hübner NO, Matthes R, Sietmann R, Kindel E, Weltmann KD, Welk A, Kramer A, Kocher T (2011). Antimicrobial efficacy of non-thermal plasma in comparison to chlorhexidine against dental biofilms on titanium discs in vitro - proof of principle experiment. Journal of Clinical
Periodontology 38(10):956-965.

Aim: Dental biofilms play a major role in the pathogenesis of peri-implant mucositis. Biofilm reduction is a pre-requisite for a successful therapy of peri-implant mucosal lesions. In this

study, we evaluated the effect of three different plasma devices on the reduction of *Streptococcus mutans* (*S. mutans*) and multispecies human saliva biofilms. Material and Methods: We assessed the efficacy of three different non-thermal atmospheric pressure plasma devices against biofilms of *S. mutans* and saliva multispecies grown on titanium discs in vitro in comparison with a chlorhexidine digluconate (CHX) rinse. Efficacy of plasma treatment was determined by the number of colony forming units (CFU) and by scanning electron microscopy. The results were reported as reduction of CFU ($CFU_{untreated}-CFU_{treated}$). Results: The application of plasma was much more effective than CHX against biofilms. The maximum reduction of CHX was 3.36 for *S. mutans* biofilm and 1.50 for saliva biofilm, whereas the colony forming units (CFU) reduction of the volume dielectric barrier discharge argon plasma was 5.38 for *S. mutans* biofilm and 5.67 for saliva biofilm. Conclusions: Treatment of single- and multispecies dental biofilms on titanium discs with non-thermal atmospheric pressure plasma was more efficient than CHX application in vitro. Thus, the development of plasma devices for the treatment of peri-implant mucositis may be fruitful.

Duske K, Koban I, Kindel E, Schröder K, Nebe B, Holtfreter B, Weltmann KD, Kocher T (2012). Atmospheric plasma enhances wettability and cell spreading on dental implant metals. Journal of Clinical Periodontology 39(4):400-407.

Objectives: Titanium (Ti) is considered to be the key biomaterial in dental implantology. Wettability and surface energy are important factors for osseointegration. We used a low temperature discharge plasma pen (kINPen08, INP, Greifswald, Germany) with argon-oxygen gas mixture and tested this device with respect to enhance surface energy and cell adhesion of human osteoblasts MG-63. To simulate a periimplantitis treatment machined Ti discs were treated with a coarse diamond bur. Methods: Argon plasma with 1% oxygen admixture was applied for three minutes. We used machined Ti discs (M, diameter 15mm, Straumann, Switzerland), with a coarse diamond bur treated discs (D), both with and without additional plasma treatment (+/-P). The surface free energy after 120s of treatment was estimated by static water contact angles (Digidrop, GBX, Bourg de Peage, France). Human osteoblastic cells MG-63 (ATCC) were plated onto the Ti specimens (22.700 cells/cm²) and cultivated in DMEM at 37°C and 5% CO2. The cell-surface contact and the cell shape were analyzed by scanning electron microscopy (SEM). Spreading (cell area in µm²) of PKH26-stained cells was measured by confocal microscopy (LSM 410). Results: The cell-surface contact could be impressively improved due to the plasma application. The contact angle decreased with plasma treatment (M-P: 87.9° ± 1.9; M+P: 0.0° ± 0; D-P: 67.5° ± 2.4; D+P: 0.3° ± 0.4) and the cell area increased significantly after 60min (M-P: 1276µm² ± 501; M+P: 1904µm² ± 522; D-P: 1045µm² ± 463; D+P: 1545µm² ± 575). Conclusion: Treatment with argon plasma with 1% oxygen admixture improves the cell-surface contact and supports the development of the cell area. This may improve tissue bonding after decontamination during a periimplantitis therapy. These results may offer a new technique to optimize implant surfaces with respect to surface energy.