

## New therapeutic effects of plasma gas containing nitric oxide

Victor N. Vasilets<sup>1</sup>, Anatoly B. Shekhter<sup>2</sup>, Anna E. Guller<sup>2</sup>, Alexander V. Pekshev<sup>3</sup>

<sup>1</sup>*Institute for Energy Problems of Chemical Physics, Chernogolovka, 142432, Russia.*

<sup>2</sup>*I.M. Sechenov First Moscow State Medical University, Moscow, 119992, Russia*

<sup>3</sup>*N.E. Bauman Moscow State Technical University, Moscow, 105005, Russia*

E-mail: [vnvasilets@yandex.ru](mailto:vnvasilets@yandex.ru)

Nitric oxide (NO) is a short-lived signaling molecule that plays an important role in a variety of physiologic functions, including inflammation and wound healing processes [1]. Therapeutic effects of different plasma sources including plasmas generated gaseous nitric oxide (gNO) has been utilized for various clinical applications [2]. Particularly the device “Plason” generating plasma gas containing gNO in atmospheric arc discharge has been used beneficially in treatment of different wound pathologies (trophic ulcers, diabetic foot ulcer) as well as in traumatology, stomatology and other medical areas [3].

At high temperatures realized in the arc discharge (2000 – 4000<sup>0</sup>K) in humid air highly reactive radical species like atomic oxygen (O), hydroxyl radicals (OH), atomic hydrogen (H) are formed in addition to NO, NO<sub>2</sub> and other nitrogen and oxygen containing species. We have calculated the concentrations of these species depending on the humidity and gas temperature. According to our simulation the concentrations of O > H > OH could be comparable with the concentration of NO generated in the discharge. The plasma flow after cooling to room temperature is composed of the warm air and the plasma-generated stable molecules like NO, NO<sub>2</sub>, H<sub>2</sub>O<sub>2</sub> and others. At present the therapeutic action of “Plason” is attributed both direct and indirect gNO regulatory effects on anti-microbe macrophages’ activity, microcirculation and regeneration and nerve conduction. We suggest it also could be intensified by the synergy effects of gNO/H<sub>2</sub>O<sub>2</sub> and gNO/O<sub>2</sub> species [4].

Recently the unique composition of NO-containing plasma gas generated by “Plason” has been successfully used in treatment of burns, skin scars and joint diseases. Reduced bleeding and the absence of wound infection at the moment of early necrectomy of extensive and deep burns have been observed after “Plason” treatment in surgical-mode. Moreover, the post operative treatment of burns using “Plason” gNO-therapy mode significantly improved microcirculation and wound healing [5]. As it has been documented in the clinical trial on 160 patients, the neck and facial excessive skin scars after the gNO-therapy undergo flattening and became softer. At the same time the recurrence rate of surgically excised keloids decreased dramatically [6]. The high efficiency of gNO plasma therapy was obtained in treatment of rheumatoid arthritis, osteoarthritis (observed as pain relief, decrease of inflammation and improved join mobility) and sport’s traumas (healing of ligaments and muscles injuries) (E. Karpinskaya, unpublished data).

### References

- [1] Ignarro L.J., Nitric Oxide: Biology and Pathology, 2009. Academic Press, 2nd Edition.
- [2] Fridman G., Friedman G., Gutsol A., Shekhter A.B., Vasilets V.N., Fridman A., Plasma Processes and Polymers (2008) **5**, 503-533.
- [3] Shekhter A.B., Serezhenkov V.A., Rudenko T.Y., Pekshev A.V., Vanin A.F., Nitric Oxide Biology and Chemistry (2005) **12**, 210-219.
- [4] Yoshioka Y., Kitao T., Kishino T., Yamamuro A., Maeda S.. J. Immunol. (2006), **176**, 4675–81.
- [5] Vyrenkov Yu., Moskalenko V., Vestnik limfologii (2006), **1**, 34 (in Russian).
- [6] Pavlovich V., Ezrokhin V., Shekhter A., Vestnik esteticheskoi medicini (2009), **2**, 43-49 (in Russian).