Comparative studies of atmospheric pressure Ar and He plasmas for enhancing cutaneous delivery of epidermal growth factor

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Abstract: In this study, we examined the comparison of non-thermal atmospheric pressure plasma (NTAPP) operating with helium and argon gases on the efficiency of drug penetration through the skin. As a result, under same volume power density, NTAPP operating with argon gas well reduced the expression of E-cadherin, leading to the enhanced transdermal delivery of the epidermal growth factor (EGF). The electrical parameters, such as applied voltage, total discharge current, electron density, plasma current and the optical emission spectroscopy (OES) are observed.

Keywords Non-thermal atmospheric pressure plasma, Transdermal drug delivery

Non-thermal atmospheric pressure plasma (NTAPP) has been well established for diverse applications in materials processing and biomedical recently. The majority of plasma used in industrial applications are operated in low pressure and almost room temperature. Because heavy species such as ions and neutrals remain almost the same as the room temperature (37 ˚C), the plasma do not cause thermal damage to heat sensitive objects. This non-equilibrium characteristic enables NTAPP for treatment heat-sensitive materials including biological tissues. To date many strategies have been made to enhance transdermal drug delivery by regulating the skin barrier structure using physical devices including ultrasound [1] and lasers [2].

In this study, we examined the comparison of non-thermal atmospheric pressure plasma (NTAPP) operating with helium and argon gases on the efficiency of drug penetration through the skin. As a result, the argon plasma showed higher efficacy for E-cadherin localization effect and EGF absorption than helium plasma under the same applied voltage and the same gas flow rate (Fig.1). Moreover, under the same power density per volume, NTAPP operating with argon gas reduced the expression of E-cadherin leading to the enhanced transdermal delivery of the epidermal growth factor (EGF) (Fig. 2). The electrical parameters, such as applied voltage, total discharge current, plasma current, and the optical emission spectroscopy (OES) are observed.

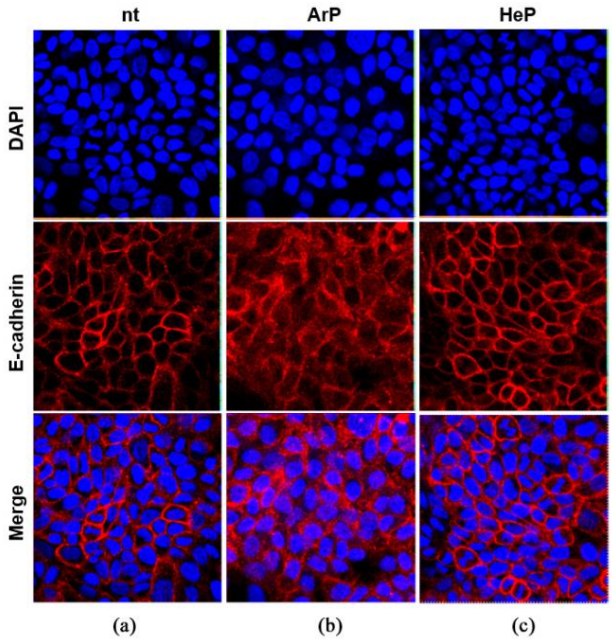

Fig. 1. Effect of the ArP and the HeP on cellular E-cadherin localization in HaCaT cells: (a) non-treated (nt) control, (b) ArP treated, and (c) HeP treated, respectively.

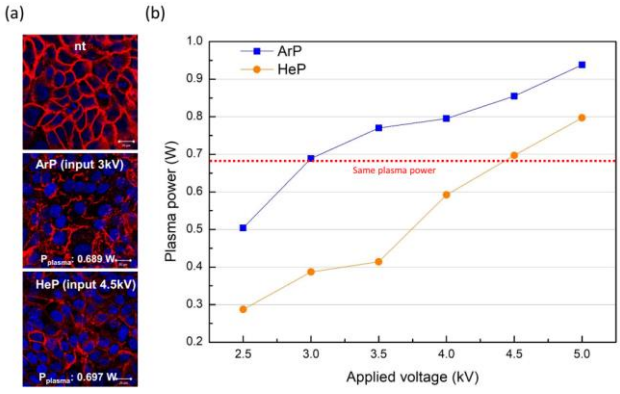

Fig. 2. (a) Results of cellular E-cadherin localization after treatment of same plasma power conditions of non-treated (nt), the argon plasma (ArP) at 3 kV and the helium plasma (HeP) at 4.5 kV. (b) Variation of the plasma power corresponding to applied voltage for the ArP (blue) and the HeP (orange).

References

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