

《正弦削波电压调控大气压氦气非平滑表面介质阻挡放电 均匀性的仿真研究》*的补充材料

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表 S1 等离子体动力学模型化学反应

Table S1. Chemical reactions considered in plasma dynamics model.

| 序号 | 反应式 | 速率常数 | 焓/eV | 文献 |
|----|--|---|--------|-----|
| 1 | $e + \text{He} \rightarrow e + \text{He}$ | $f(\bar{\mathcal{E}})$ | 0 | [1] |
| 2 | $e + \text{He} \rightarrow e + \text{He}^*$ | $f(\bar{\mathcal{E}})$ | 19.82 | [1] |
| 3 | $e + \text{He} \rightarrow 2e + \text{He}^+$ | $f(\bar{\mathcal{E}})$ | 24.58 | [1] |
| 4 | $e + \text{N}_2 \rightarrow 2e + \text{N}_2^+$ | $f(\bar{\mathcal{E}})$ | 15.6 | [1] |
| 5 | $e + \text{He}^* \rightarrow 2e + \text{He}^+$ | $4.661 \times 10^{-16} \times T_e^{0.6} \times e^{-4.78/T_e}$ | 4.78 | [2] |
| 6 | $e + \text{He}_2^* \rightarrow 2e + \text{He}_2^+$ | $9.75 \times 10^{-16} \times T_e^{0.71} \times e^{-3.4/T_e}$ | 3.4 | [2] |
| 7 | $e + \text{He}^* \rightarrow e + \text{He}$ | 2.9×10^{-15} | -19.82 | [3] |
| 8 | $e + \text{He}_2^* \rightarrow e + 2\text{He}$ | 3.8×10^{-15} | -17.9 | [3] |
| 9 | $e + \text{He}^+ \rightarrow \text{He}^*$ | $6.76 \times 10^{-19} \times T_e^{-0.5}$ | 0 | [4] |
| 10 | $e + \text{He}_2^+ \rightarrow 2\text{He}$ | 1.0×10^{-14} | 0 | [5] |
| 11 | $e + \text{He}_2^+ \rightarrow \text{He}^* + \text{He}$ | $8.9 \times 10^{-15} \times (T_e/0.026)^{-1.5}$ | 0 | [5] |
| 12 | $e + \text{He} + \text{He}^+ \rightarrow \text{He}^* + \text{He}$ | $1.0 \times 10^{-38} \times (T_e/0.026)^{-2}$ | 0 | [5] |
| 13 | $e + \text{He} + \text{He}_2^+ \rightarrow 3\text{He}$ | 2.0×10^{-39} | 0 | [3] |
| 14 | $e + \text{N}_2^+ \rightarrow \text{N}_2$ | $4.8 \times 10^{-13} \times (T_e/0.026)^{0.5}$ | 0 | [6] |
| 15 | $e + \text{N}_4^+ \rightarrow 2\text{N}_2$ | $2.0 \times 10^{-12} \times (T_e/0.026)^{0.5}$ | 0 | [6] |
| 16 | $\text{He}_2^* + M \rightarrow 2\text{He} + M$ | 1.0×10^6 | 0 | [7] |
| 17 | $2\text{He} + \text{He}^+ \rightarrow \text{He} + \text{He}_2^+$ | 1.1×10^{-43} | 0 | [6] |
| 18 | $\text{He}^* + 2\text{He} \rightarrow \text{He}_2^* + \text{He}$ | 2.0×10^{-46} | 0 | [6] |
| 19 | $\text{He}^* + \text{He}^* \rightarrow e + \text{He}_2^+$ | 1.5×10^{-15} | 0 | [6] |
| 20 | $\text{He}_2^* + \text{He}_2^* \rightarrow e + 2\text{He} + \text{He}_2^+$ | 1.5×10^{-15} | 0 | [6] |
| 21 | $\text{N}_2 + \text{He}_2^+ \rightarrow \text{He}_2^* + \text{N}_2^+$ | 1.4×10^{-15} | 0 | [6] |
| 22 | $2\text{N}_2 + \text{N}_2^+ \rightarrow \text{N}_2 + \text{N}_4^+$ | 1.9×10^{-41} | 0 | [6] |
| 23 | $\text{He} + \text{N}_2 + \text{N}_2^+ \rightarrow \text{He} + \text{N}_4^+$ | 1.9×10^{-41} | 0 | [6] |
| 24 | $\text{N}_2 + \text{N}_4^+ \rightarrow 2\text{N}_2 + \text{N}_2^+$ | 2.5×10^{-21} | 0 | [6] |
| 25 | $\text{He} + \text{N}_4^+ \rightarrow \text{He} + \text{N}_2 + \text{N}_2^+$ | 2.5×10^{-21} | 0 | [6] |
| 26 | $\text{He}^* + \text{N}_2 \rightarrow e + \text{He} + \text{N}_2^+$ | 5.0×10^{-17} | 0 | [6] |
| 27 | $\text{He}_2^* + \text{N}_2 \rightarrow e + 2\text{He} + \text{N}_2^+$ | 3.0×10^{-17} | 0 | [6] |

注: $f(\bar{\mathcal{E}})$ 是平均电子能的函数, 通过向 Bolsig⁺ 导入电子碰撞反应截面数据计算得到; He* 代

表 He(2^3S)及 He(2^1S), He $_2^*$ 则代表 He $_2(a^3\Sigma_u^+)$; M 代表模型所包含的所有重粒子; 双体和三体反应的速率常数分别为 $m^3 \cdot s^{-1}$ 和 $m^6 \cdot s^{-1}$ 。

表 S2 介质板表面反应^[3]

Table S2. Surface reactions considered in dielectric plate^[3].

| 序号 | 反应式 | 黏附系数 | 二次电子发射系数 | 二次电子平均能量/eV |
|----|------------------------------|------|----------|-------------|
| 1 | He $^+ \rightarrow$ He | 1 | 0.02 | 5 |
| 2 | He $_2^+ \rightarrow$ 2He | 1 | 0.02 | 5 |
| 3 | He $^* \rightarrow$ He | 1 | 0 | 0 |
| 4 | He $_2^* \rightarrow$ 2He | 1 | 0 | 0 |
| 5 | N $_2^+ \rightarrow$ N $_2$ | 1 | 0.001 | 3 |
| 6 | N $_4^+ \rightarrow$ 2N $_2$ | 1 | 0.001 | 3 |

参考文献

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