§19. Effect of Vibrational Excitation of Molecular Hydrogen on Hydrogen Recycling in LHD Edge Plasma


We have constructed a neutral particle transport code which contains recent atomic and molecular data especially concerning the molecular assisted recombination (MAR) which may enhance the plasma recombination in the higher temperature region where the conventional collisional-radiative recombination becomes ineffective. Figure 1 shows the rate coefficients of the MAR.  

\[ \text{H}_2(v) + e \rightarrow \text{H}_2(v') + e \]  
\[ \text{H}_2(v) + e \rightarrow \text{H}_2(v') + e \]

Fig. 1. The MAR rate coefficients from various initial vibrational levels in \( \text{H}_2(X^1\Sigma_g^+) \). \( T_e = 1 \text{eV}, n_e = 10^{12} \text{cm}^{-3} \). Because the MAR rate coefficient strongly depends on initial vibrational levels of \( \text{H}_2(X^1\Sigma_g^+, v) \), the \( v = 0 - 15 \) levels are distinguished in our code. All atomic and molecular processes considered are listed below.

- \( \text{H}^+ + e \rightarrow \text{H} \)
- \( \text{H}_2 + \text{e} \rightarrow \text{H}^+ + \text{H}^+ \)
- \( \text{H}_2^+(v) + e \rightarrow \text{H}_2^+(v') + e \)
- \( \text{H}^+ + \text{H}^+ \rightarrow \text{H}^+ + \text{H}^+ \)
- \( \text{H}_2 \rightarrow \text{H}_2^+ + \text{e} \)
- \( \text{H}_2^+ \rightarrow \text{H}_2 \) 

Fig. 2 and 3 show some output examples of a calculation under a condition that uniform \( T_e = 1 \text{eV} \) and \( n_e = 10^{12} \text{cm}^{-3} \) are assumed for \( \rho \geq 1.0 \) region where available data of these parameters is few. The vibrational level of \( \text{H}_2(X^1\Sigma_g^+, v = 0) \) which is released from the divertor plate is set to \( v = 0 \) in this calculation.

Fig. 2. Density distributions of \( \text{H}_2(X^1\Sigma_g^+, v = 0) \) and \( \text{H}(1s) \). For \( \rho \geq 1.0 \) region, uniform \( T_e = 1 \text{eV} \) and \( n_e = 10^{12} \text{cm}^{-3} \) are assumed.

Fig. 3(a) Densities of \( \text{H}_2(X^1\Sigma_g^+, v) \) and \( \text{H}(1s) \), and (b) Balmer \( \alpha \) emission intensities originating from various paths, along center horizontal line in Fig. 2.

Reference