Effective ammonia synthesis by synchronizing of pressure swing and discharge switching

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In this study, we propose a novel ammonia synthesis process in which the pressure of N_2-H_2 plasma swings from low to high value with synchronizing the pressure-swing and the discharge switching. Ammonia is industrially one of the most important compounds and consumes huge amount of energy in its production process. The low-temperature and high-pressure condition is thermodynamically preferable for the ammonia synthesis from feedstock of nitrogen and hydrogen molecules. In the plasma process, nitrogen molecule can be dissociated by electron impact reactions in non-thermal plasma even though the translational gas temperature is very low. However, in non-thermal plasma, low-pressure condition is preferable to avoid arc transition, and also to dissociate nitrogen molecule because electron energy is high when the pressure of the plasma system is low. Hence, we previously proposed an ammonia synthesis process in which the pressure of N_2-H_2 plasma swings from low to high value. In order to save the energy consumption and avoid the decomposition of the ammonia already synthesized, we synchronized the pressure-swing and the discharge switching. In other words, this condition is to ignite the plasma at low pressure and turn off the discharging at high pressure. We have compared energy efficiency for ammonia synthesis between conventional pressure-swing system and the new one. The relatively higher energy efficiency was obtained by the new operating condition. We discuss this mechanism in detail to confirm the effectiveness of this condition.