PRODUCTION OF $\bullet CH_2NH_2$ AND CH_2NH IN THE REACTIONS OF METHYLAMINE (CH_3NH_2) WITH $\bullet$H OR $\bullet$OH IN SOLID *p*-H_2 AND ITS IMPLICATION IN ASTROCHEMISTRY

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Methylamine (CH_3NH_2) is considered to be a potential precursor for the formation of interstellar glycine through the reaction between aminomethyl radical ($\bullet CH_2NH_2$) and HOCO, but direct evidence of the formation and spectral identification of $\bullet CH_2NH_2$ remains unreported. Taking advantage of unique properties associated with the *para*-hydrogen (*p*-H_2) matrix, we performed the reaction H + CH_3NH_2 in solid *p*-H_2 at 3.2 K. To generate H atoms, photolysis at 365 nm of a co-deposited mixture of CH_3NH_2/*p*-H_2 and Cl_2 to produce Cl atoms and subsequent IR irradiation for promoting the Cl + H_2 (ν = 1) $\rightarrow$ H + HCl reaction were carried out. IR spectra of $\bullet CH_2NH_2$ and CH_2NH were observed upon UV/IR irradiation and when the matrix was maintained in darkness. The new IR spectrum of $\bullet CH_2NH_2$ clearly indicates that $\bullet CH_2NH_2$ can be formed from the reaction H + CH_3NH_2 in dark interstellar clouds. Experiments on CD_3NH_2 produced CHD_2NH_2, in addition to $\bullet CD_2NH_2$ and CD_2NH, confirming the occurrence of H addition to $\bullet CD_2NH_2$. The potential-energy scheme of H + CH_3NH_2 reactions reveals the feasibility of sequential H-abstraction and H-addition reactions for the formation of products observed in this study. The observed dual-cycle mechanism containing two consecutive H-abstraction and two H-addition steps chemically connects CH_3NH_2 and CH_2NH and might imply their quasi-equilibrium. In another experimental method, photolysis at 250 nm of a H_2O_2-doped CH_3NH_2/p-H_2 matrix was performed to generate $\bullet$OH to facilitate the $\bullet$OH + CH_3NH_2 reaction; further reaction of $\bullet$OH + H_2 $\rightarrow$ H_2O + H might also trigger the H + CH_3NH_2 reaction. Significantly more $\bullet CH_2NH_2$ was produced than in CH_3NH_2/Cl_2/*p*-H_2 experiments, consistent with a barrier predicted for $\bullet$OH + CH_3NH_2 much smaller than that for H + CH_3NH_2. All species observed herein are plausible starting materials for interstellar glycine in molecular clouds.