Electronic Supplementary Information

Photocatalytic degradation of unsymmetrical dimethylhydrazine on TiO_2/SBA-15 under 185/254 nm vacuum-ultraviolet

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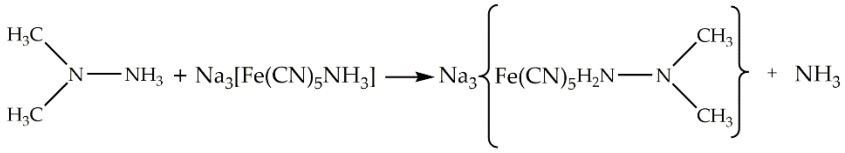
This supplementary material portion contains 3 texts, 14 figures and 1 table.

Text S1. Quantitative analysis of unsymmetrical dimethylhydrazine (UDMH)

Trace amounts of UDMH react with amino ferrocyanide sodium in a weakly acidic aqueous solution and form a red complex (S1). In the measurement range, the absorbance measured at 500 nm with a spectrophotometer is proportional to the concentration of UDMH. In this part, the calibration curve of UDMH solution at different concentration ranging from 0.08 - 0.52 $mg \cdot L^{-1}$ was made and displayed in Fig. S2.



S1

Text S2. Details of GC/MS conditions for analysis of UDMH intermediates.

The GC/MS column used was PE Elite-WAX ETR (30 m * 0.25 μm * 0.25 mm) polar capillary column. The flow rate of carrier gas (He) was 1.5 mL min^{-1}. The injection volume was 1 μL in a split mode at the split ratio of 10:1. The pre-injection sample washes was two. The temperature of injector was 150 °C. An oven isothermal program was held at 50 °C for 1 min, then ramped up to 100 °C for 1 min (10 °C min^{-1}), and finally ramped up to 180 °C for 1 min (10 °C min^{-1}). The mass spectrometer was performed in a full scan mode and collected data from m/z 30-100 amu with 1.9 min of solvent delay. Electron impact ionization was 70 eV and an ion source temperature was 200 °C.

Text S3. Preparation of TiO_2 by hydrolysis method.

TiO_2 prepared by hydrolysis method via the following steps: 10 mL titanium butoxide was added into a three-necked flask containing 100 mL water under magnetic stirring conditions. After aging for 24 h, the slurry was filtered, washed by water, dried at 60 ℃ and calcined at 500 ℃ for 4 h in air. The sample was denoted as H-TiO_2, and the specific surface area of H-TiO_2 was 185.46 $m^2 \cdot g^{-1}$.

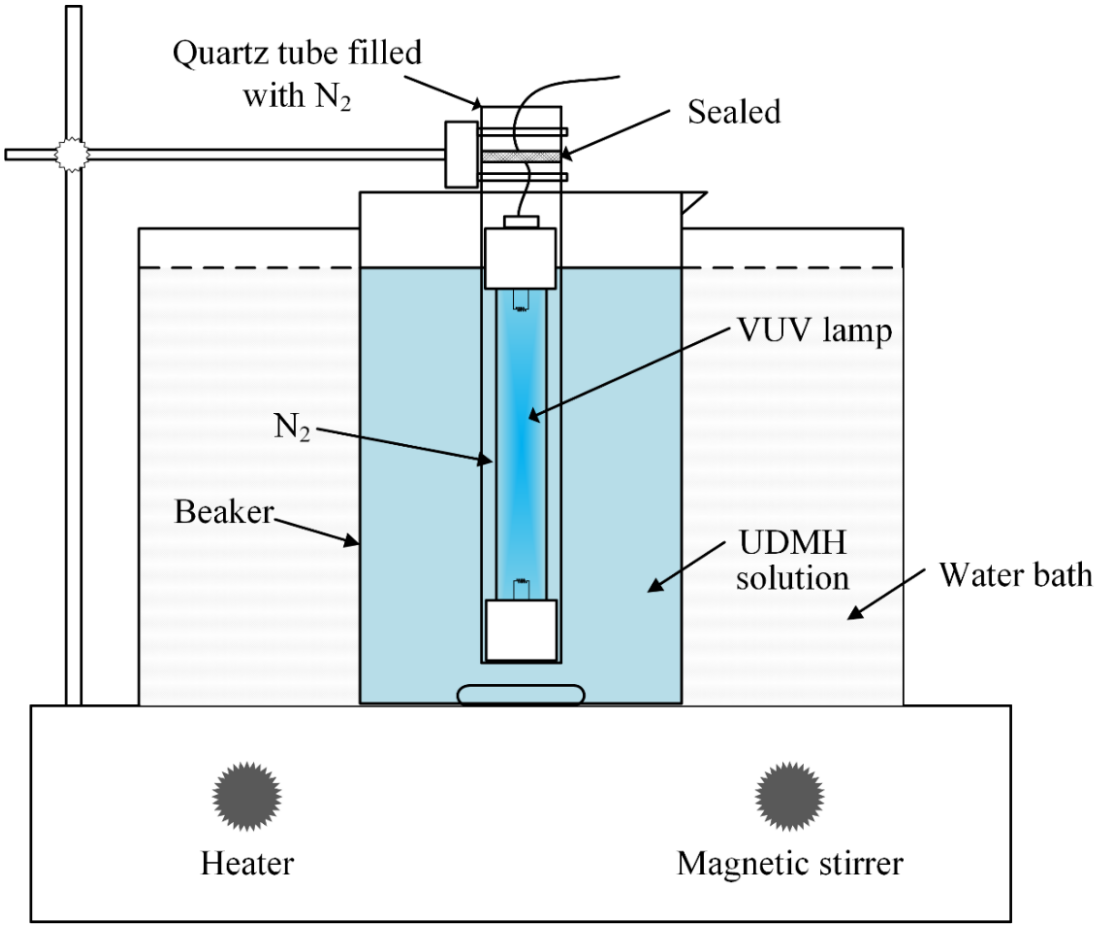


Fig. S1. The experimental set-up of the PCD reactor.

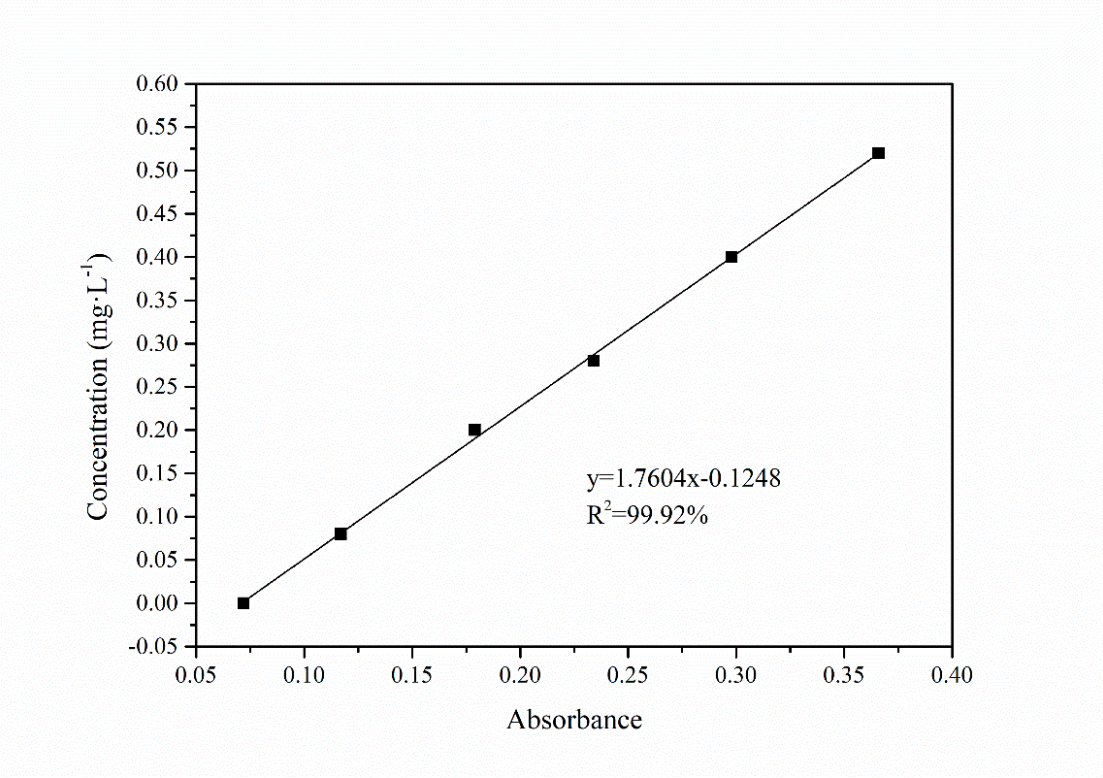


Fig. S2. The calibration curve of UDMH solution.

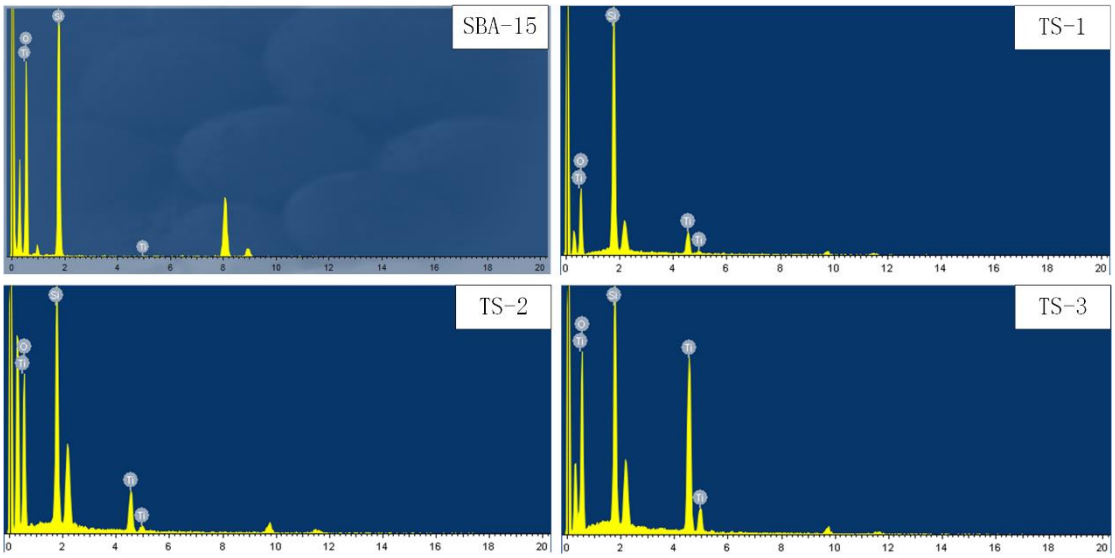


Fig. S3. EDS images of the samples.

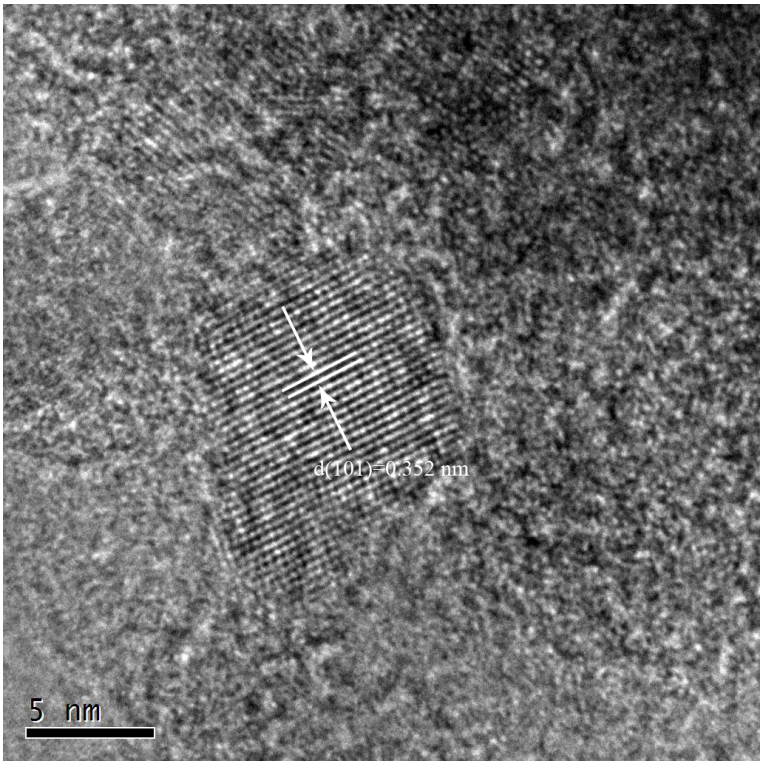


Fig. S4. HRTEM image of TiO_2 nanoparticle encapsulated in TS-2.

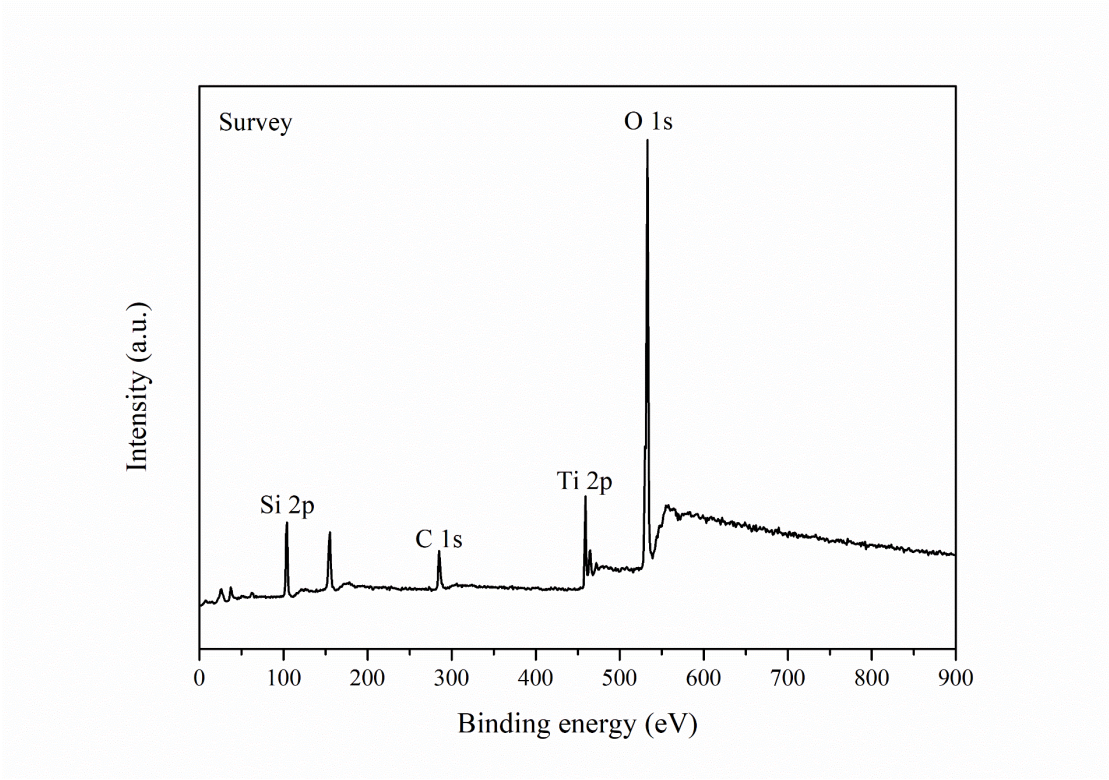


Fig. S5. XPS spectra of TS-2 survey spectra.

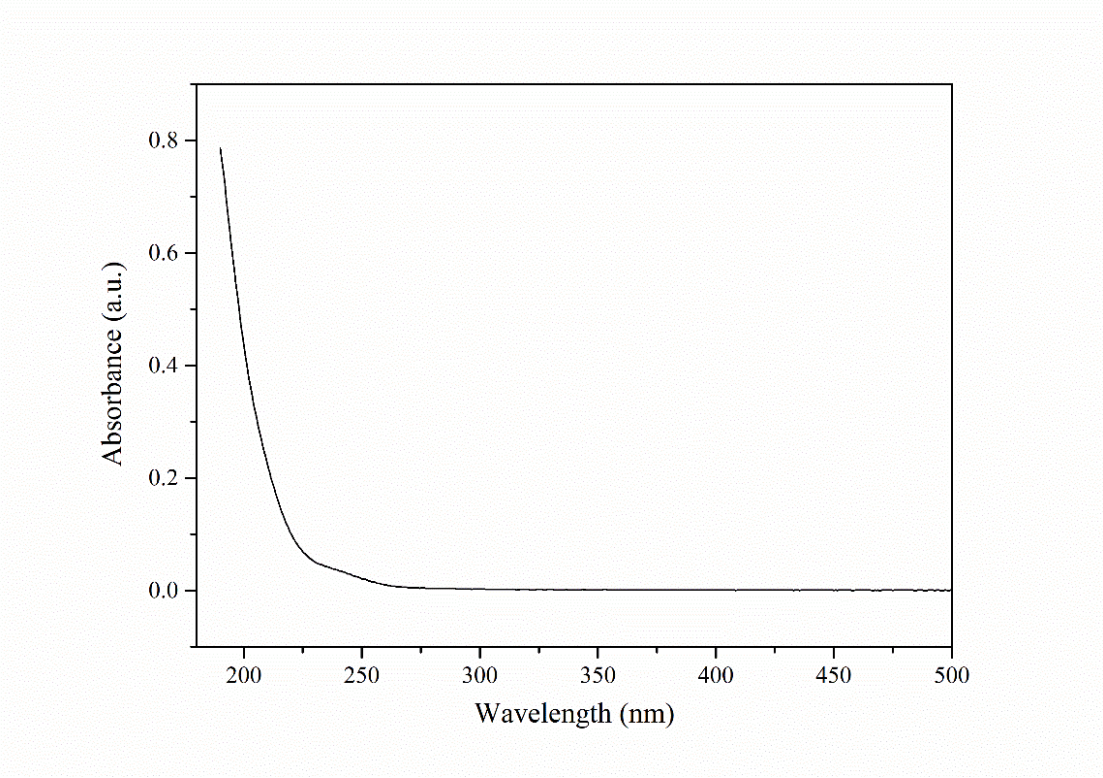


Fig. S5. The UV absorption curve of UDMH at 190～500 nm.

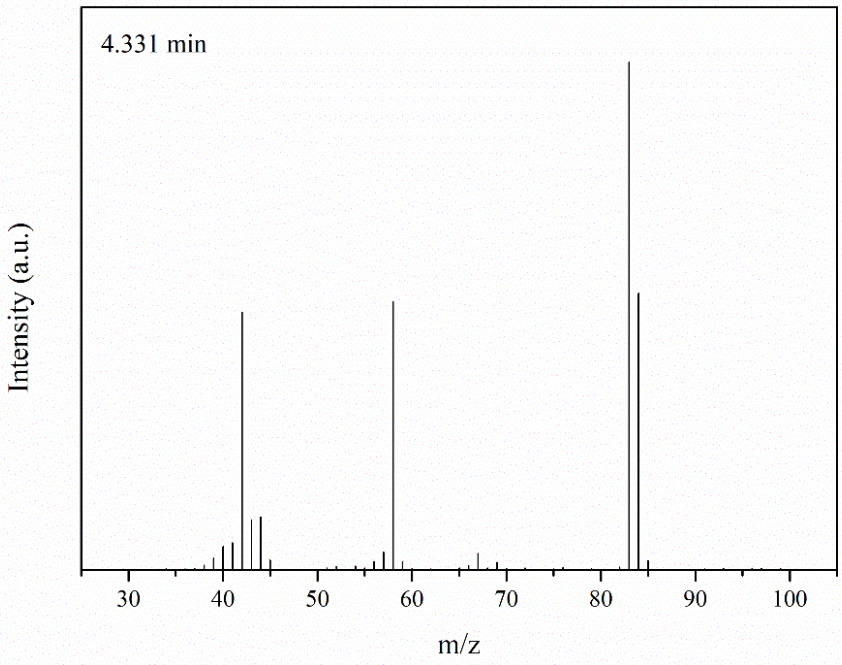


Fig. S6. GC/MS spectrum of intermediate product: Dimethylamino acetonitrile.

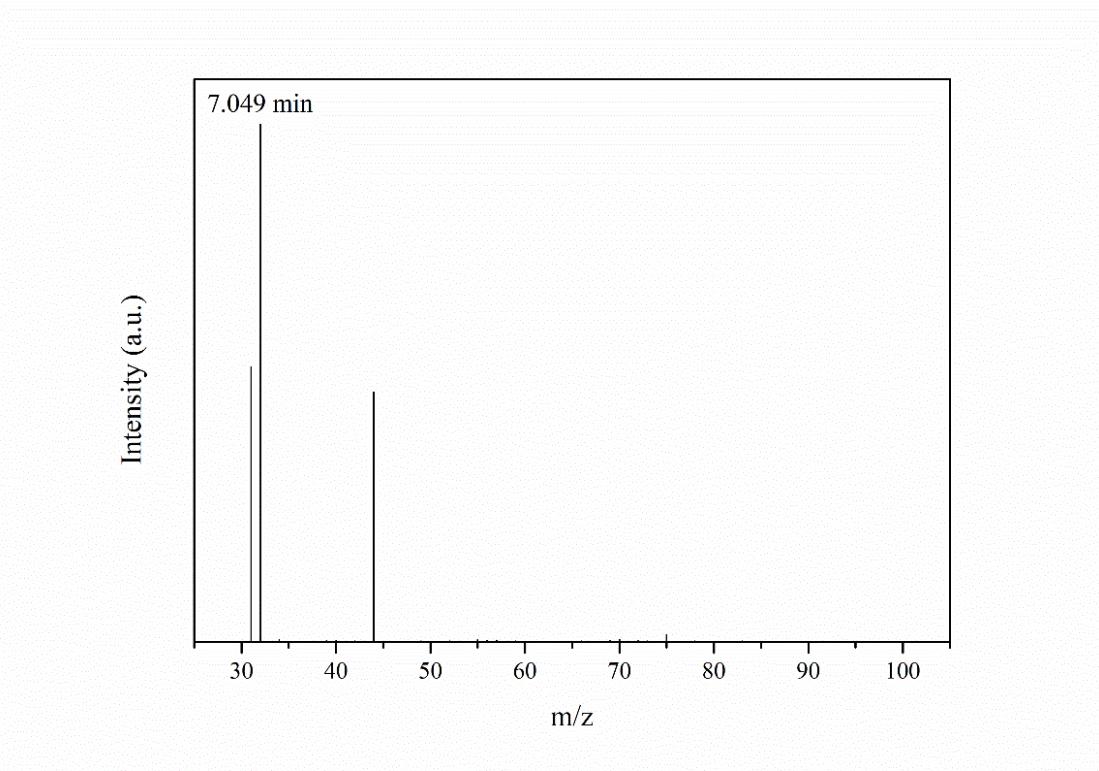


Fig. S7. GC/MS spectrum of intermediate product: Hydrazinecarboxamide.

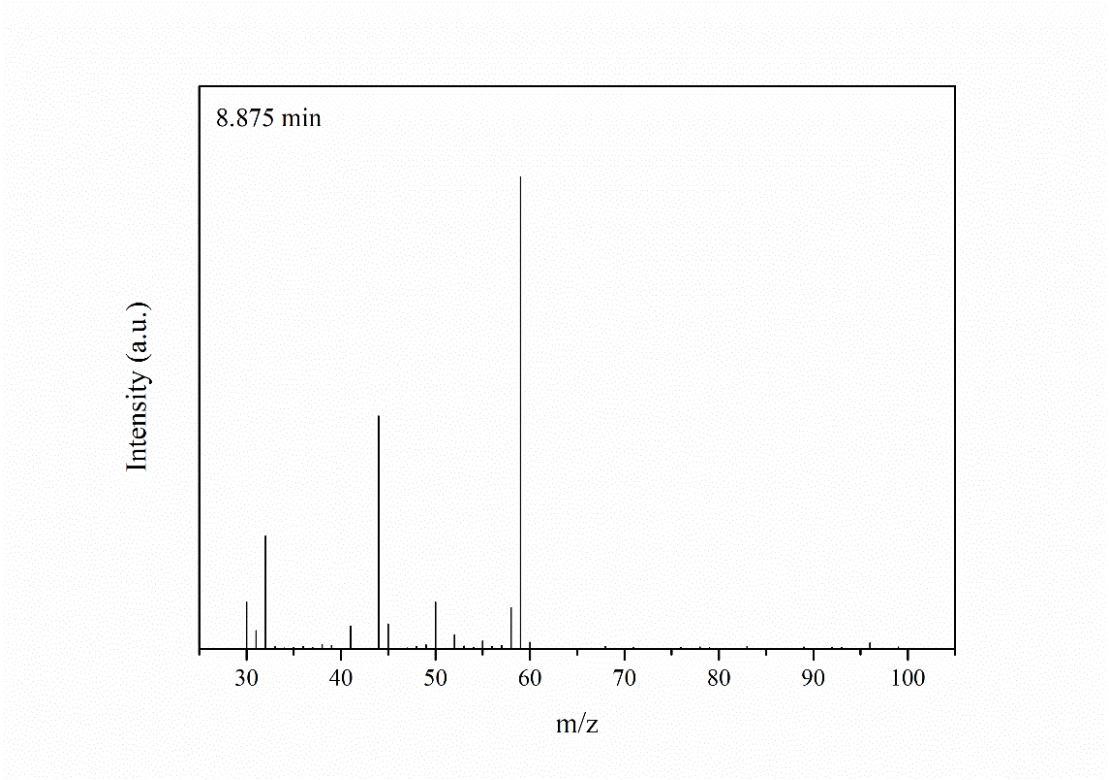


Fig. S8. GC/MS spectrum of intermediate product: Methyl formamide.

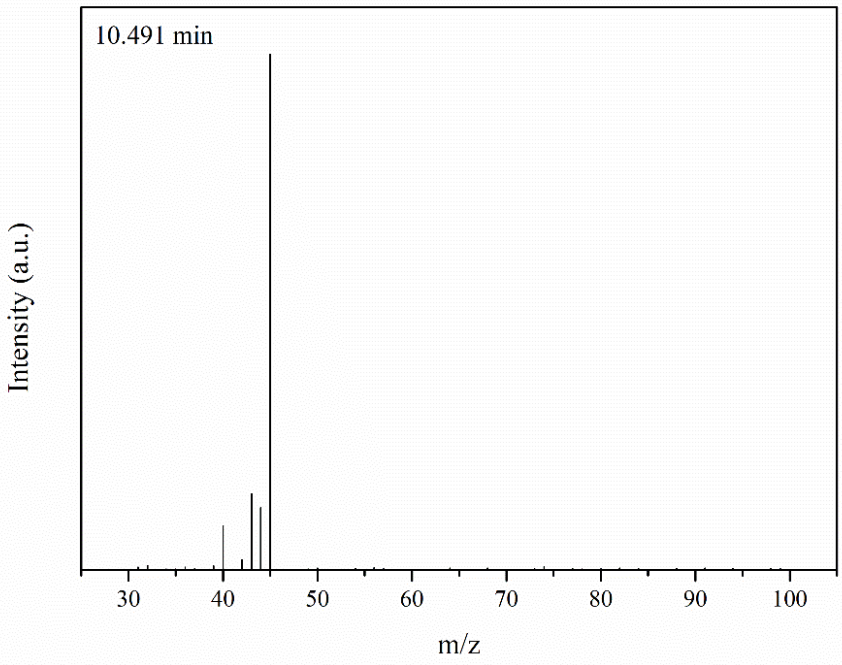


Fig. S9. GC/MS spectrum of intermediate product: Formamide.

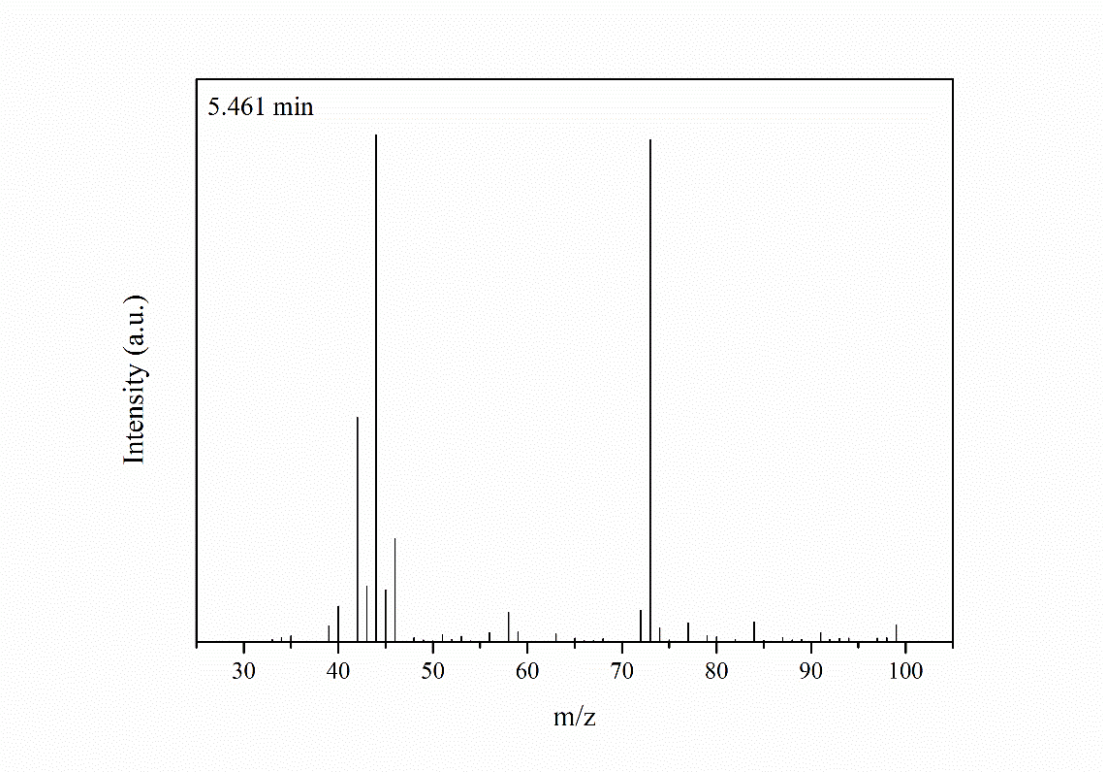


Fig. S10. GC/MS spectrum of intermediate product: Dimethylformamide.

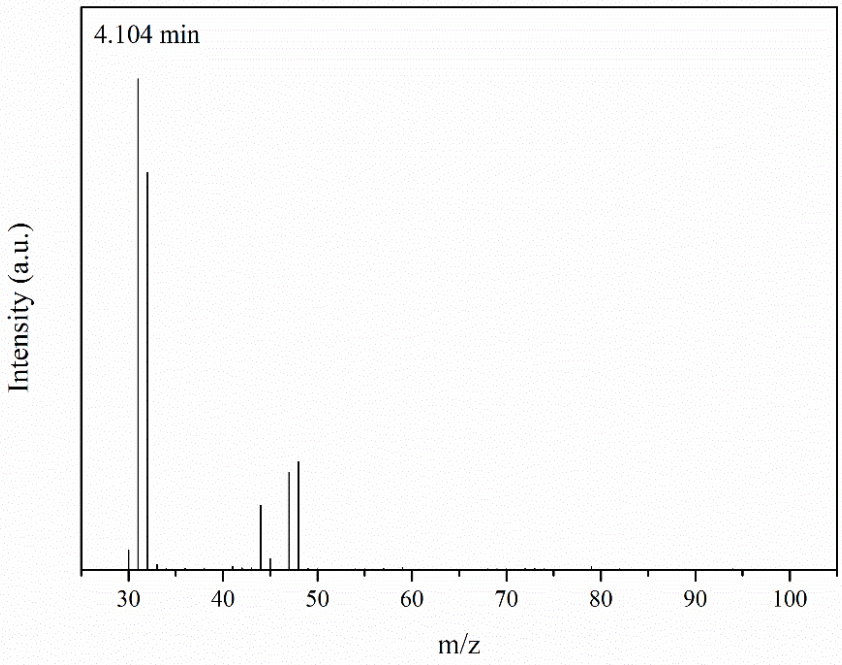


Fig. S11. GC/MS spectrum of intermediate product: Methanol.

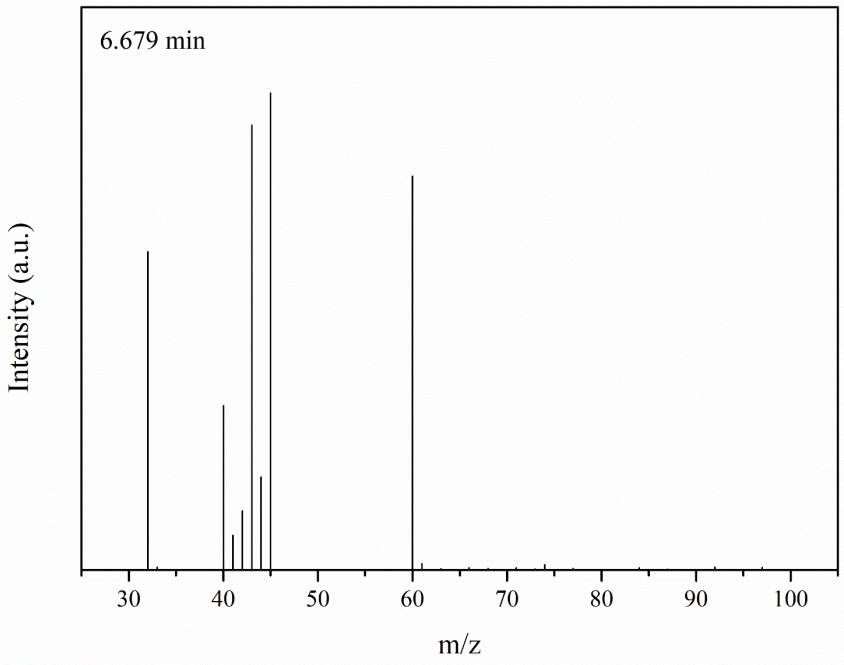


Fig. S12. GC/MS spectrum of intermediate product: Acetic acid.

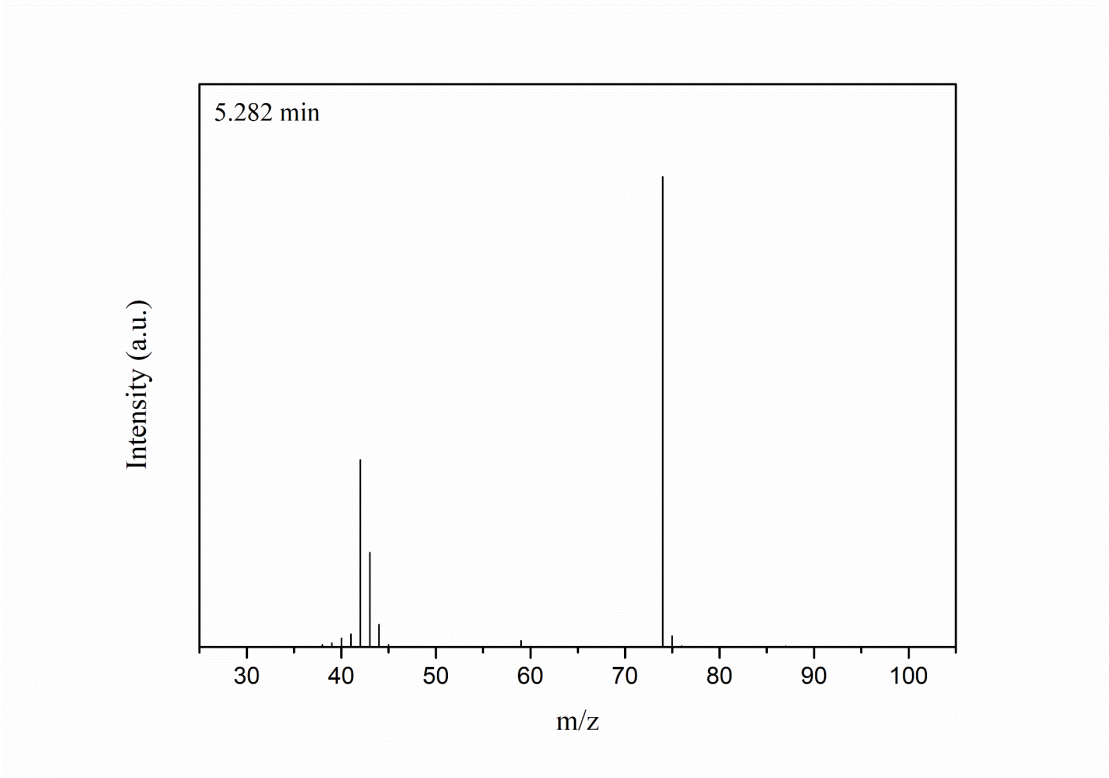
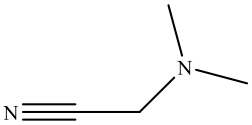
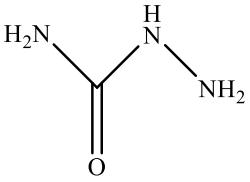
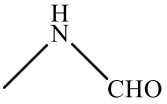
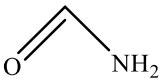
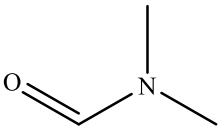
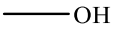
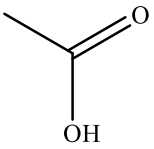
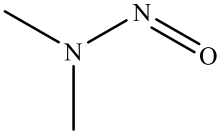


Fig. S13. GC/MS spectrum of intermediate product: N-Nitrosodimethylamine.

Table S1. The intermediate products for the degradation of UDMH in VUV/TS-2 process.

Rank*	Retention time (min)	Name	CAS	Chemical structure	Exact mass (m/z)
1	4.331	Dimethylamino acetonitrile	926-64-7		84
2	7.049	Hydrazine carboxamide	57-56-7		75
3	8.875	Methyl formamide	123-39-7		59
4	10.491	Formamide	75-12-7		45
5	5.461	Dimethylformamide	68-12-2		73
6	4.104	Methanol	67-56-1		32
7	6.679	Acetic acid	64-19-7		60
8	5.282	N-Nitrosodimethylamine	62-75-9		74

*Ranked by peak intensity.