Supplementary Information (SI)

Insights into Electric- and Thermal-Induced Decomposition and Gas Evolution of Silicone Rubber through Experiments and Molecular Simulations

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S1. Details of the electrical decomposition experiments

S1.1 Gas collection

The electrode sheet is clamped between two thin sheets of silicone rubber and placed inside a sealed gas-generating box; the discharge intensity is adjusted by changing the electrode spacing d=1, 3, or 5 mm.

S1.2 Boost and breakdown voltage

A step-by-step voltage increase (1 kV every 1 min) was employed until a high-energy discharge occurred and triggered material breakdown. The breakdown voltages in air atmosphere were approximately 1.4 kV, 2.0 kV, and 4.8 kV, and in argon atmosphere, they were 1.3 kV, 2.8 kV, and 4.7 kV, respectively.

S1.3 Discharge duration

The discharge is a single event with a short duration (approximately 0.16 ns) and does not sustain a long-lasting arc.

S1.4 Energy input

The discharge energy is estimated using $E = \frac{1}{2}C{V_{bd}}^2$. The equivalent capacitance of the device in this paper is in the range of 10-100 pF (typical small fixture/wire range). Calculated using C=10 pF, the discharge energies for 1, 3, and 5 mm electrode spacings are 9.8, 20, and 115.2 μJ in air atmosphere, and 8.45, 39.2, and 110.45 μJ in argon atmosphere, respectively. Note that the specific value of the equivalent capacitance may vary depending on the device and wiring, and some error may exist. Organize the data into tableS1.

Table S1. Estimated discharge energies for different electrode spacings in air and Ar atmospheres (C = 10 pF).

Electrode spacing (mm)	**Atmosphere**	**Breakdown voltage V_{bd} (kV)**	**Discharge energy** $E = \frac{1}{2}C{V_{bd}}^2$ (μ**J**)
1	Air	1.4	9.8
1	Argon	1.3	8.45
3	Air	2.0	20.0
3	Argon	2.8	39.2
5	Air	4.8	115.2
5	Argon	4.7	110.45

S1.5 Uncertainty explanation

The breakdown distance may be affected by the electrode placement and the flatness of the silicone rubber surface. When oblique breakdown occurs, the breakdown distance increases, thus affecting the experimental accuracy.

S2. Comparison of Thermal and Electric Decomposition Mechanisms

To address the reviewer's comment on the differences in chemical pathways between thermal decomposition and electrical decomposition. Table S2 summarizes the differences in chemical pathways between thermal decomposition and electrical decomposition.

Table S2. Comparison of thermal and electrical decomposition of SiR.

	Thermal decomposition	**Electrical decomposition**
Reaction mechanism	Thermally induced chain breakage / rearrangement	Electrothermal coupling chain breakage / free radical generation
Reaction products	CO_2、CO、CH_4、D3、D4	Mainly CH_4、C_2H_2、SiH_4
Influencing factors	Temperature	Electric field and temperature

S3. Gas Products from Thermal Decomposition of SiR

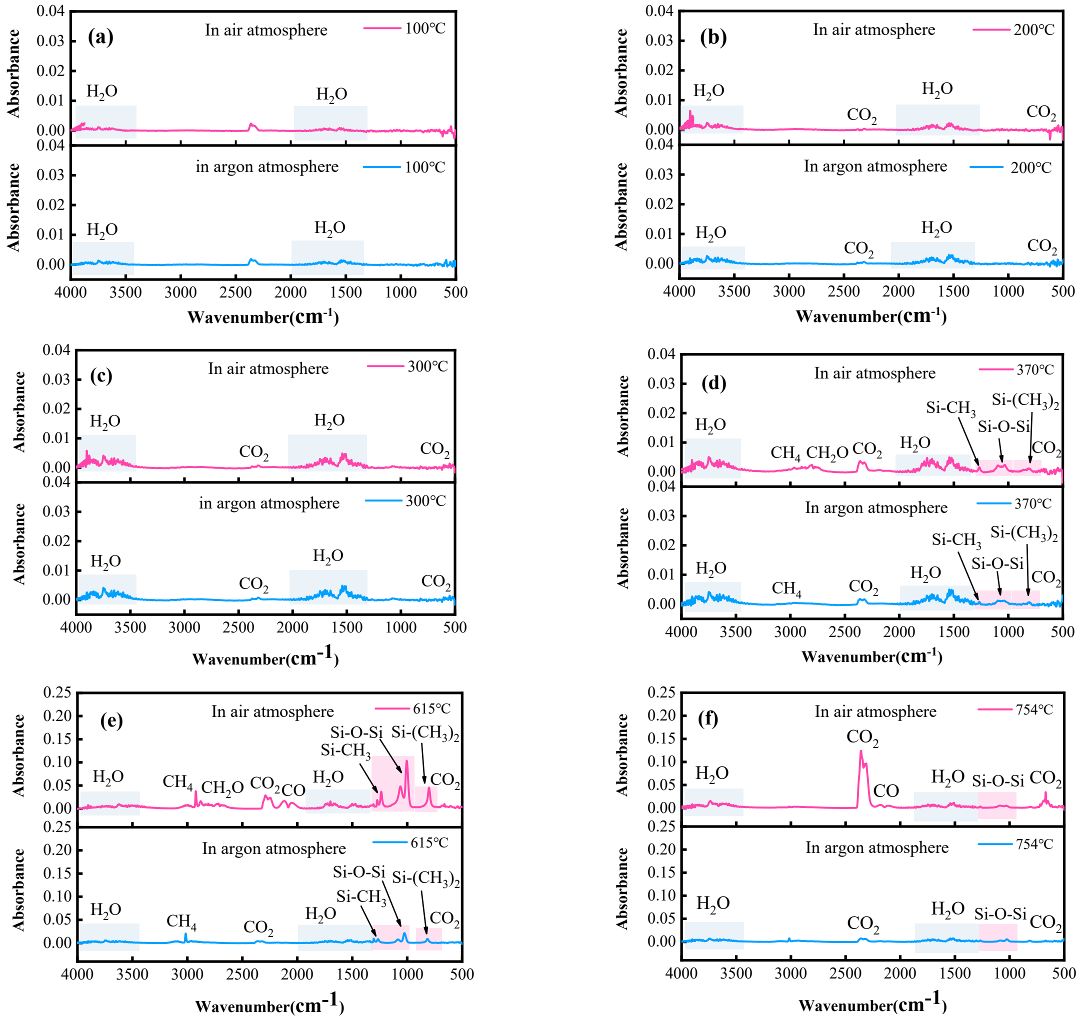

Fig. S1 IR spectra of the thermal release gases from SiR at (a) 100 °C, (b) 200 °C, (c) 300 °C, (d) 370 °C, (e) 615 °C, and (f) 754 °C in air and argon atmospheres.