Supporting information

Non-thermal Plasma Assisted Non-oxidative Methane Liquefaction for Fuel

Production at Near Ambient Conditions

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Equations

Average methane conversion was determined by:

 CH_4 conversion (%) = (1 - $\frac{moles of unreacted CH_4}{moles of fed CH_4}) \times 100\mathbb{Z}$

The selectivity of total gas products (S_G, C%) was defined by:

$$S_{G}(C\%) = \frac{\sum(\text{mole of gas product } i \times \text{carbon number of gas product } i)}{\text{mole of converted } CH_{4}}$$

The selectivity of total solid products (S_S, C%) was determined by:

 $\mathbf{S}_{S}(C\%) = \frac{mass \ of \ coke \ on \ spent \ electrode \ and \ catalyst}{mass \ of \ carbon \ in \ the \ converted \ CH_4}$

The liquid product selectivity (S_L, C%) was defined as:

 $S_{\rm L}(\rm C\%) = 100 - S_{\rm G} - S_{\rm S}$

The gas product composition was determined by micro-GC results.

The liquid product composition was given by GC-MS results.

Energy efficiency (EE) was defined as:

 $EE\left(\frac{mmol}{kJ}\right) = \frac{mmoles of converted methane per second}{P_{input} (W)} \times 1000$

Figures



Fig. S1 Schematic of performance evaluation system.



Fig. S2 Emission spectrum of the CH₄/Ar plasma.

To analyze the important species generated during the NTP-assisted methane liquefaction, the light released from CH_4/Ar plasma was captured by a UV/vis spectrometer. As shown in Fig. S2, C_1 (300-450 nm), C_2 (500-650 nm), and H (488 nm) species are detected in the emission spectrum of the CH_4/Ar plasma, (1-3) suggesting plasma can activate methane and generate these energetic species in the NTP reactor.



Fig. S3 The carbon distribution of paraffins in liquid product collected from the glass bead run, SBA-15 run, and control run.



Fig. S4 TGA analysis of spent catalyst under air. a) SBA-15; b) HZSM-5(23); c) HZSM-5(80); d) HZSM-5(280); e) UZSM-5(80).

Fig. S5 Methane conversion of fresh and reloaded SBA-15 in the 4-hour runs.

CH ₄ flow rate	CH ₄ conversion	Power	EE	Ref.
(sccm)	(%)	(W)	(mmol/kJ)	
10	43.3	21	0.140	This work
20	20	20	0.136	(4)
20	36	50	0.098	(4)
20	45	80	0.077	(4)
20	46.5	100	0.063	(4)
30	38	100	0.078	(4)
40	31	100	0.084	(4)
60	23	100	0.094	(4)
100	18	100	0.123	(4)
2	48.3	120	0.005	(5)
10	64	30	0.145	(6)
10	73	70	0.071	(6)
10	77	155	0.034	(6)
10	79	270	0.020	(6)
20	63.7	100	0.087	(7)

 Table S1 The reported energy efficiency of NTP-assisted non-oxidative methane

 conversion.

References

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