plasma

MDPI

Supplementary Materials:

Investigating the Effects of Gliding Arc Plasma Discharge's Thermal Characteristic and Reactive Chemistry on Aqueous PFOS Mineralization

Mobish A. Shaji [1,*], Mikaela J. Surace [2], Alexander Rabinovich [1], Christopher M. Sales [2], Gregory Fridman [3], Erica R. McKenzie [4] and Alexander Fridman [1]

[1] C&J Nyheim Plasma Institute, Drexel University, Camden, NJ 08103, USA
[2] Department of Civil, Architectural and Environmental Engineering, Drexel University, Philadelphia, PA 19104, USA
[3] AAPlasma LLC, Philadelphia, PA 19146, USA
[4] Department of Civil and Environmental Engineering, Temple University, Philadelphia, PA 19122, USA
* Correspondence: ma3748@drexel.edu

1. Supplementary Information pertaining to results in section 3.1

Table S1. *Estimation of ~average plasma gas temperature accounted for evaporation during treatments in air GAP discharge.*

Column Identification	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Experiment Number	Air Flow rate kg/h	Power Supplied (W)	Volume loss due to evaporation (g)	Heat of vaporization for water (J/g)	Energy lost due to Evaporation (J) $E = C \times D$	Power spent for evaporation (W) $F = \frac{E}{12 \times}$	Power Supplied for ionizaition, accounted for evaporation (W)	Enthalpy of gas (kJ/kg) $H = \frac{G \times 36(}{A}$	Specific heat of air (kJ/kg K) at room temperature	Temperature of gas (°C) $J = \left(\frac{H}{I} + 300\right) - 273$
1	2.4	260	43	2260	97180	131	129	202	1.005	~200
2	2.7	400	76	2260	171760	232	168	220	1.005	~250
3	2.7	480	85	2260	192100	260	220	289	1.005	~300
4	2.7	518	94	2260	212440	287	231	303	1.005	~350

Table S2. *Estimation of ~average plasma gas temperature accounted for evaporation during treatments in nitrogen GAP discharge.*

Column Identification	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**

Experiment Number	Nitrogen Flow rate kg/h	Power Supplied (W)	Volume loss due to evaporation (g)	Heat of vaporization for water (J/g)	Energy lost due to Evaporation (J) $E = C \times D$	Power spent for evaporation (W) $F = \frac{E}{12 \times}$	Power Supplied for ionization, accounted for evaporation (W)	Enthalpy of gas (kJ/kg) $H = \frac{G \times 36}{A}$	Specific heat of nitrogen (kJ/kg K) at room temperature	Temperature of gas (°C) $J = \left(\frac{H}{I} + 300\right) - 273$
1	2.3	240	36	2260	81360	110	130	202	1.04	~200
2	2.4	425	66	2260	149160	202	223	338	1.04	~350
3	2.4	450	62	2260	140120	189	261	394	1.04	~400

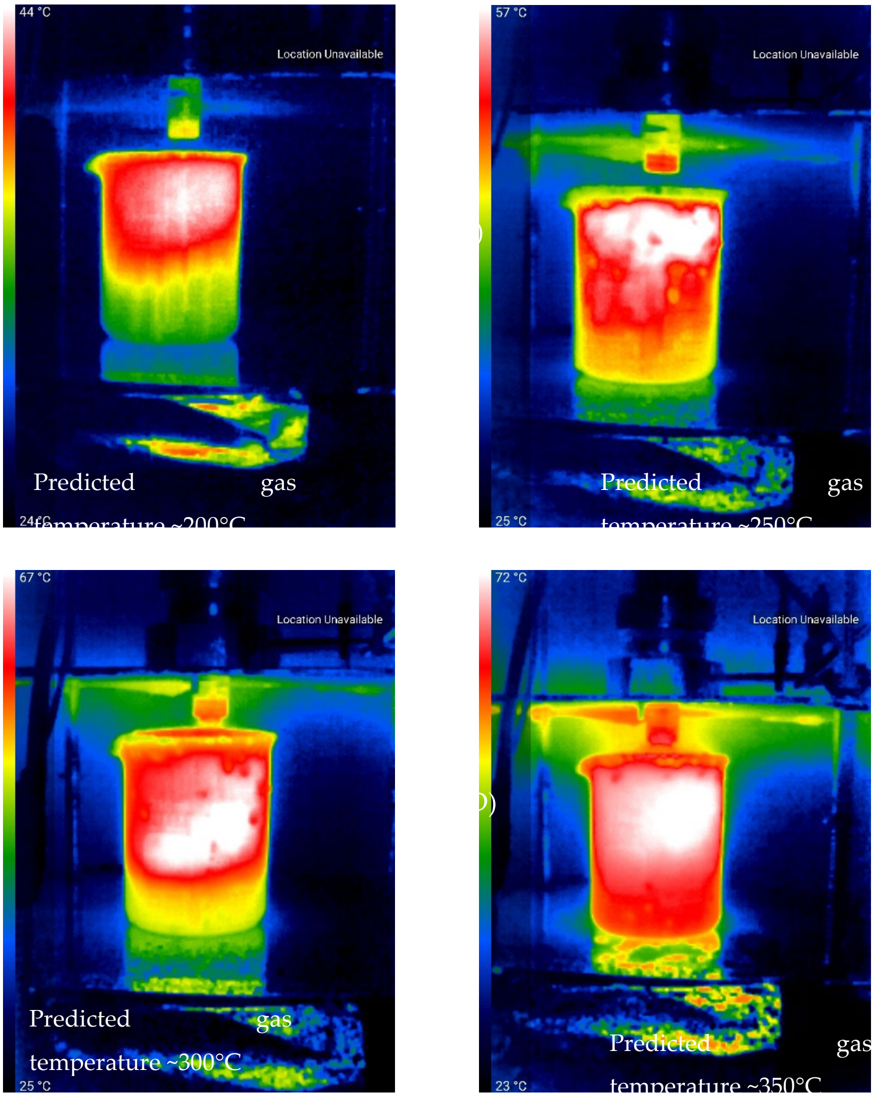
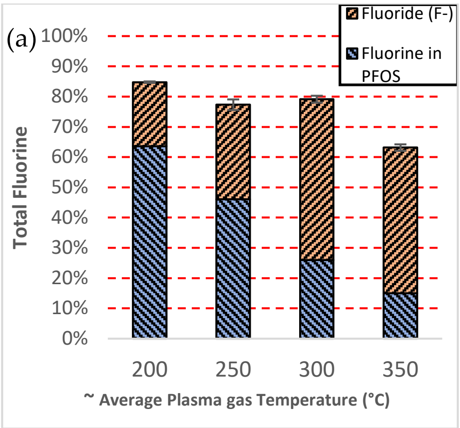


Figure S1. Thermal images of reactor during operation in air GAP discharge when predicted ~average plasma gas temperature was: (A) ~200°C, (B)~250°C, (C)~300°C, (D)~350°C.



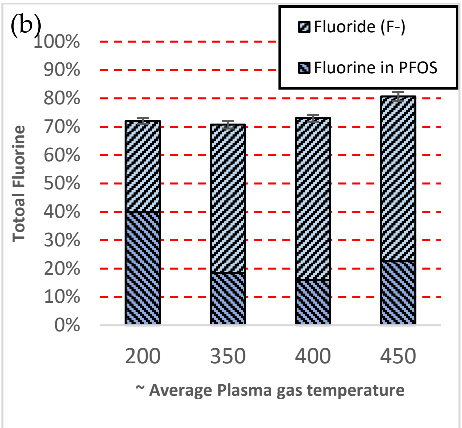


Figure S2. Fluorine mass balance of samples during treatments with GAP discharges in (a) air and (b) nitrogen at plasma gas temperatures.

2. Supplementary information pertaining to results in section 3.2

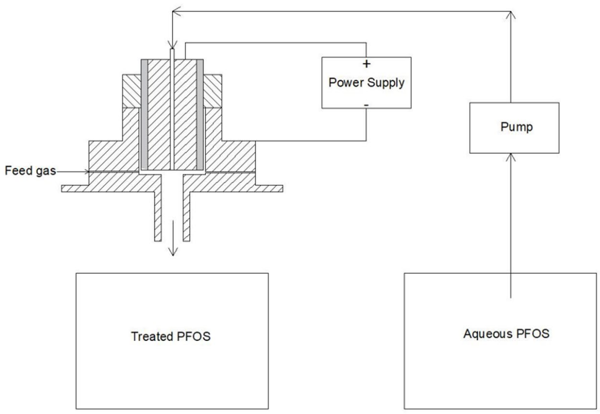


Figure S3. Schematic of reactor in multiple pass mode of operation.

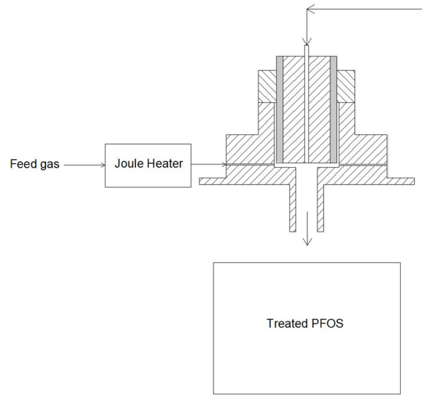


Figure S4. Schematic of reactor during treatments where air heated to ~300°C was used as feed gas and without supplying any energy.

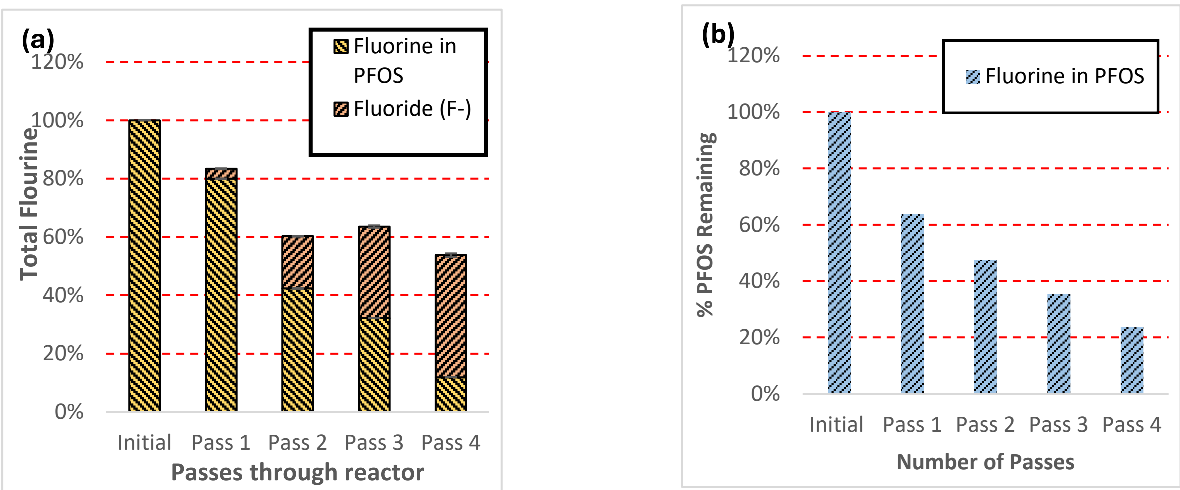


Figure S5. Fluorine mass balance of samples during multiple pass treatments with (a) GAP discharges in air and (b) heated air.

3. Supplementary information pertaining to results in section 3.3

Table S3. *Estimation of ~average plasma gas temperature accounted for evaporation during treatments in air and argon GAP discharges discussed in section 3.3 (details of the duplicate experiments are provided).*

Column Identification	A	B	C	D	E	F	G	H	I	J

Experiment Number	Feed gas Flow rate kg/h (SCFH)	Power Supplied (W)	Volume loss due to evaporation (g)	Heat of vaporization for water (J/g)	Energy lost due to Evaporation (J) $E = C \times D$	Power spent for evaporation (W) $F = \frac{E}{12 \times}$	Power Supplied for ionization, accounted for evaporation (W)	Enthalpy of gas (kJ/kg) $H = \frac{G \times 36}{A}$	Specific heat of gas (kJ/kg K) at room temperature	Temperature of gas (°C) $J = \left(\frac{H}{I} + 300\right) - 273$
Argon Experiment # 1	2.3 (50)	75	15	2260	33900	47	28	43	0.52	~110
Argon - Experiment # 2	2.3 (50)	60	14	2260	31640	43	17	27	0.52	~80
Air Experiment # 1	1.7 (50)	130	26	2260	58760	82	48	102	1.005	~125
Air Experiment # 2	1.7 (50)	130	36	2260	81360	113	17	36	1.005	~63

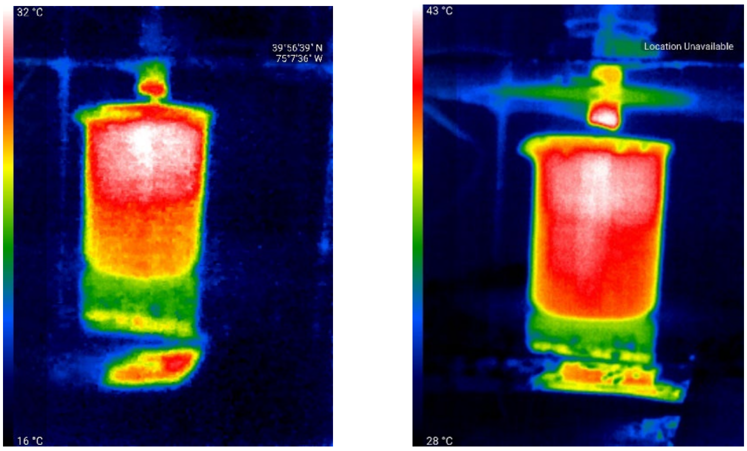
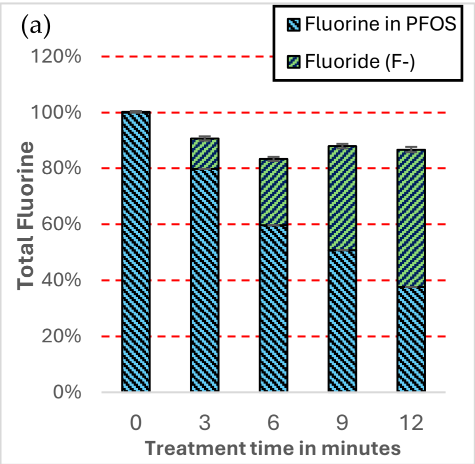


Figure S6. Thermal images of reactor during operation under (a) Argon discharge, (b) Air discharge with operation parameters as provided in Table 2.



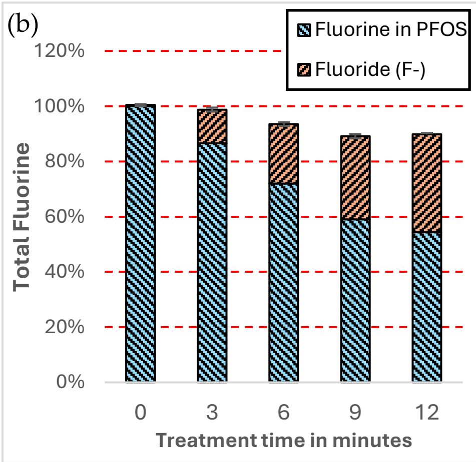


Figure S7. Fluorine mass balance of samples during treatments with GAP discharges in (a) argon and (b) air.

4. Calculation S1: Estimating mass of fluorine in PFOS

Known,

Concentration (C_{PFOS}) and volume (V_{PFOS}) of PFOS being treated.

Step 1:

Mass of PFOS being treated, $Mass_{PFOS} = C_{PFOS} \times V_{PFOS}$

Step 2:

Moles of PFOS being treated: $Mol_{PFOS} = \frac{Mass_{PFOS}}{Molar\ mass\ of\ PFOS\ (500.13\ g)}$

Step 3:

Moles of F being treated, $Mol_F = Mol_{PFOS} \times 17\ (number\ of\ F\ in\ PFOS)$

Step 4:

Mass of of F being treated, or **Mass of fluorine in PFOS**, $Mass_F$

$$Mass_F = Mol_F \times molar\ mass\ of F$$