E-cigarette Aerosol Dynamics in a Physical Model of the Adult Human Oral/Pharyngeal Cavity

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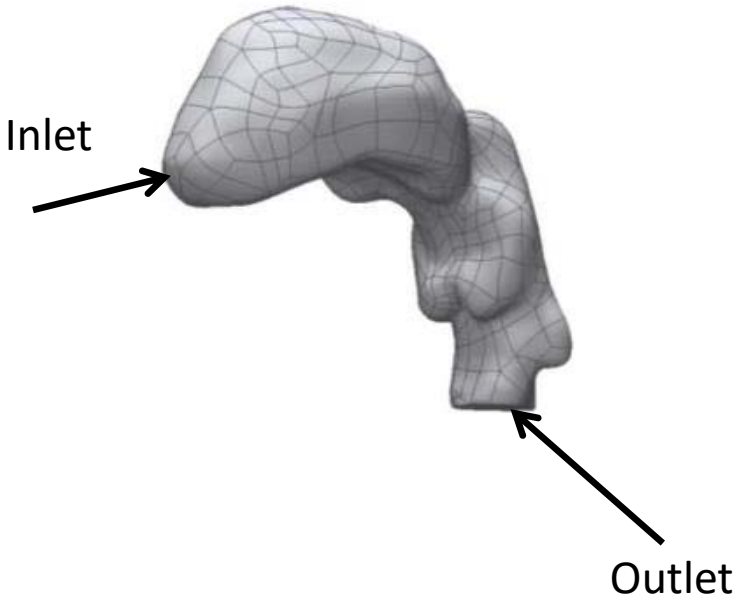
Objective

- To generate experimental data to validate a computational fluid dynamic (CFD) model for e-cigarette aerosol deposition in respiratory tract

Physical Model

- Physical Prototypes created from digital geometry using 3D printer
- Wall covered with a layer of cotton cloth that can be saturated with water to reflect high relative humidity in respiratory tract

Oral/Larynx/Pharynx section



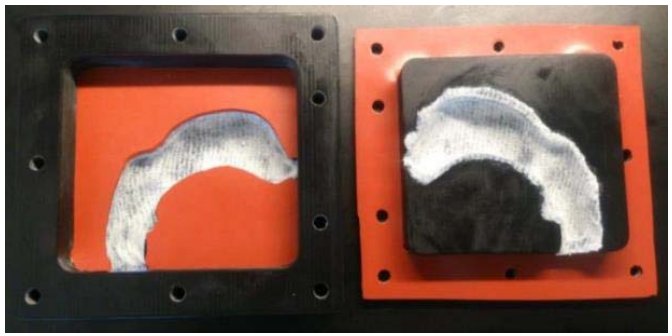


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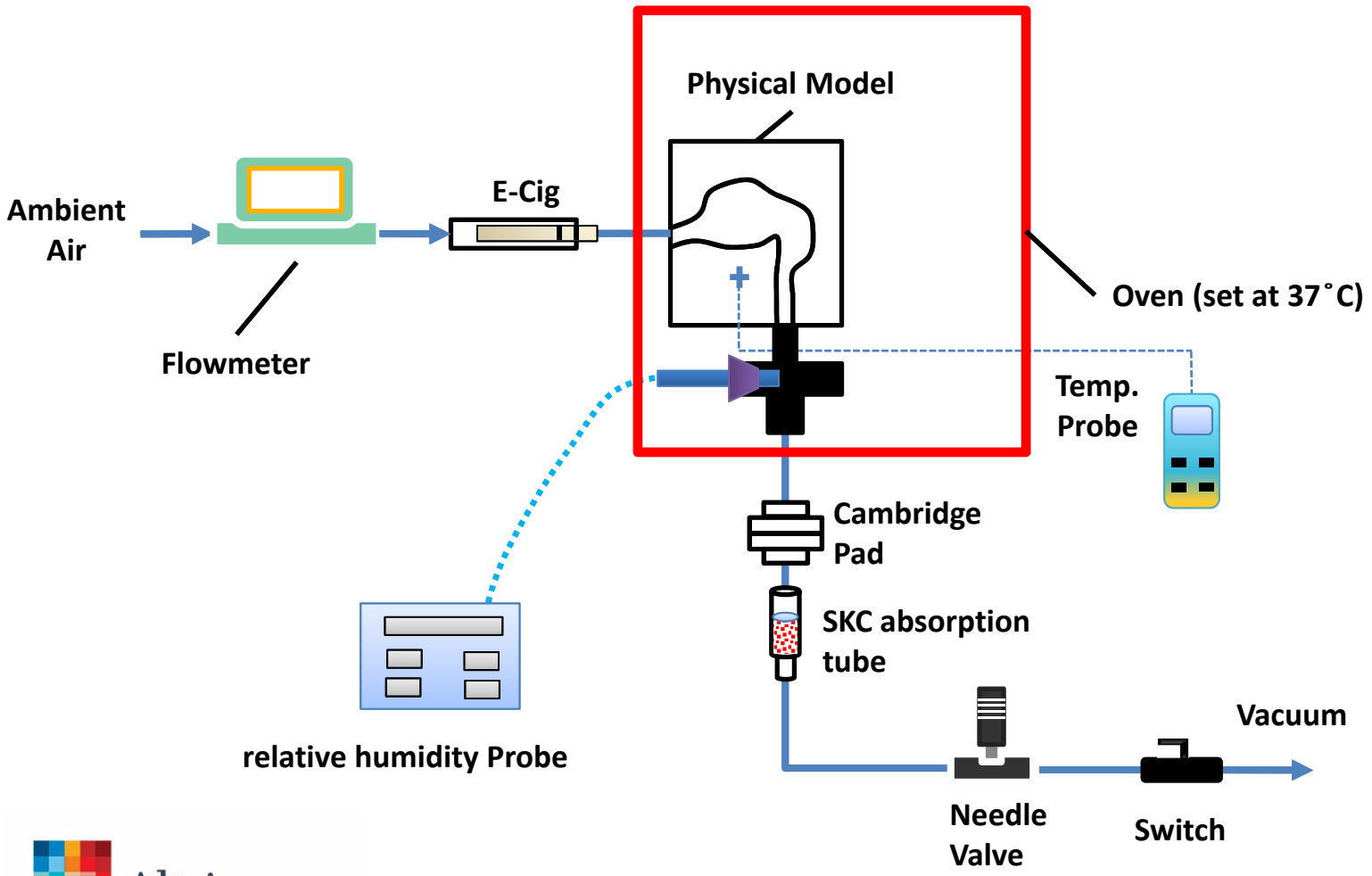
Diagram of the Experimental Setup



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Experimental Conditions

Case	E-liquid composition	puff duration (sec.)	puff volume (cc)	Temperature (C)	Wall conditions
N-1	2.5% Nicotine by weight (NBW), 15% water, 49.5% PG/Gly 33%	3	55	37	wet
N-2	2.5% NBW, 15% water, 49.5% PG/Gly 33%	3	55	37	dry
N-3	100% Propylene Glycol (PG)	3	55	37	wet
N-4	100% Glycerin (Gly)	3	55	37	wet

- 3 puffs E-cig warm up
- 1.1 L/min constant flow rate
- 11 sec air wash between puffs
- 3 replicates /cartridge and 3 cartridges/case
- 5 puffs for gravimetric analysis
- single puff for chemical analysis using GC/MS

- Doesn't represent real inhalation
- Single fixed geometry
- Simple formulations without flavors

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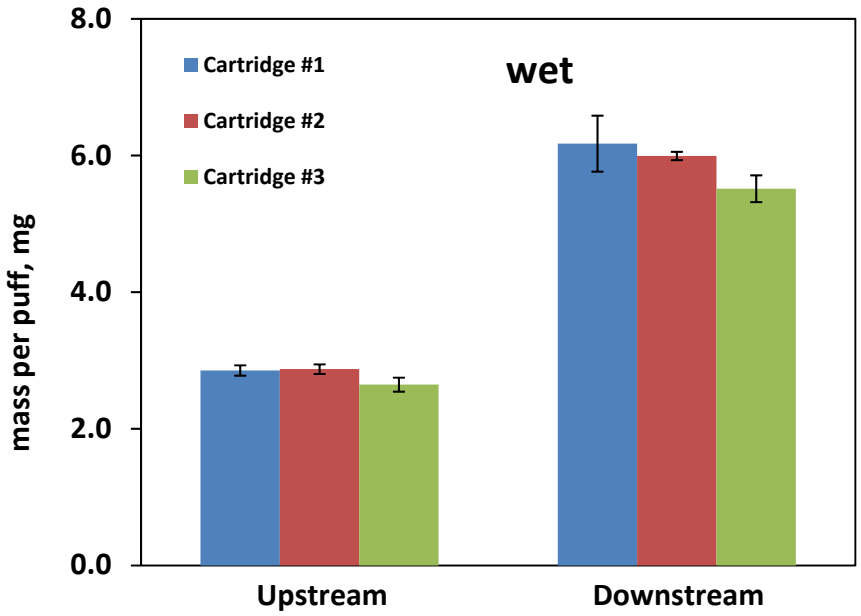
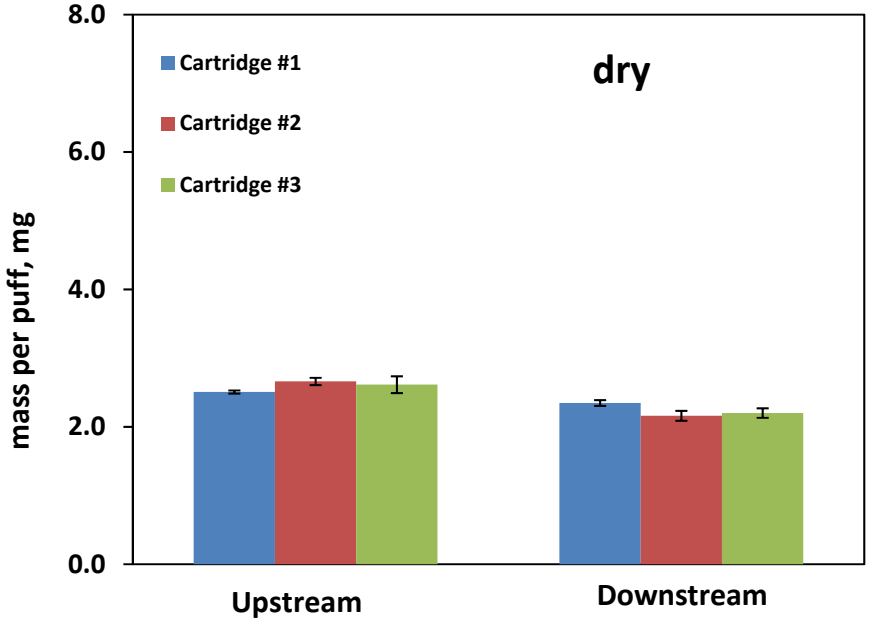
Gravimetric Analysis

Results – Gravimetric Analysis





2.5% NBW, 15% water, 49.5% PG/Gly 33%

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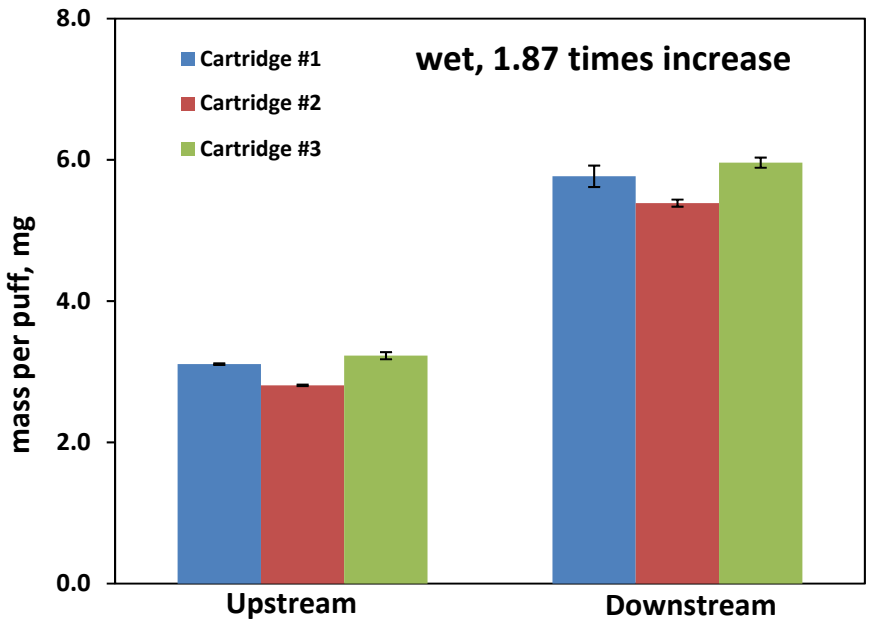
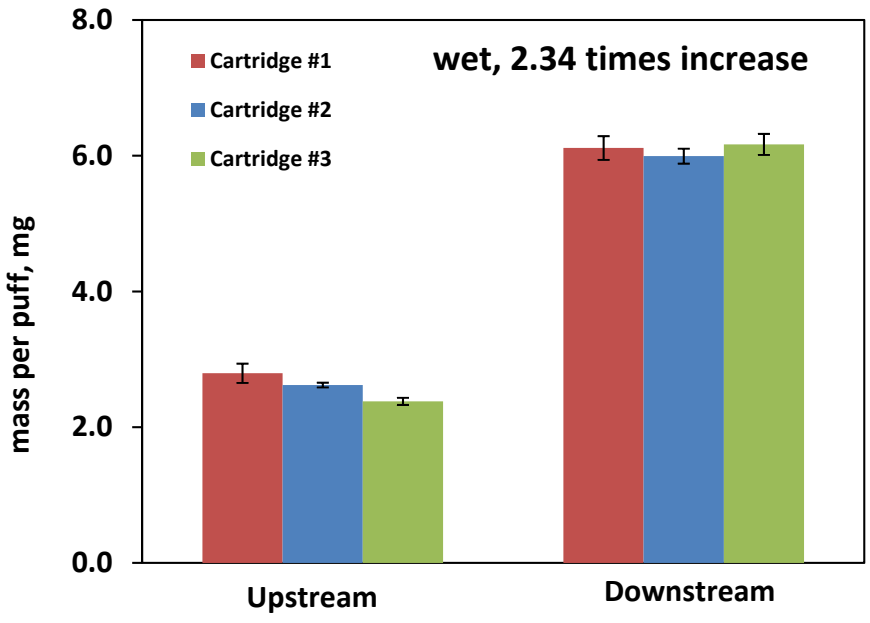
Results – Gravimetric Analysis



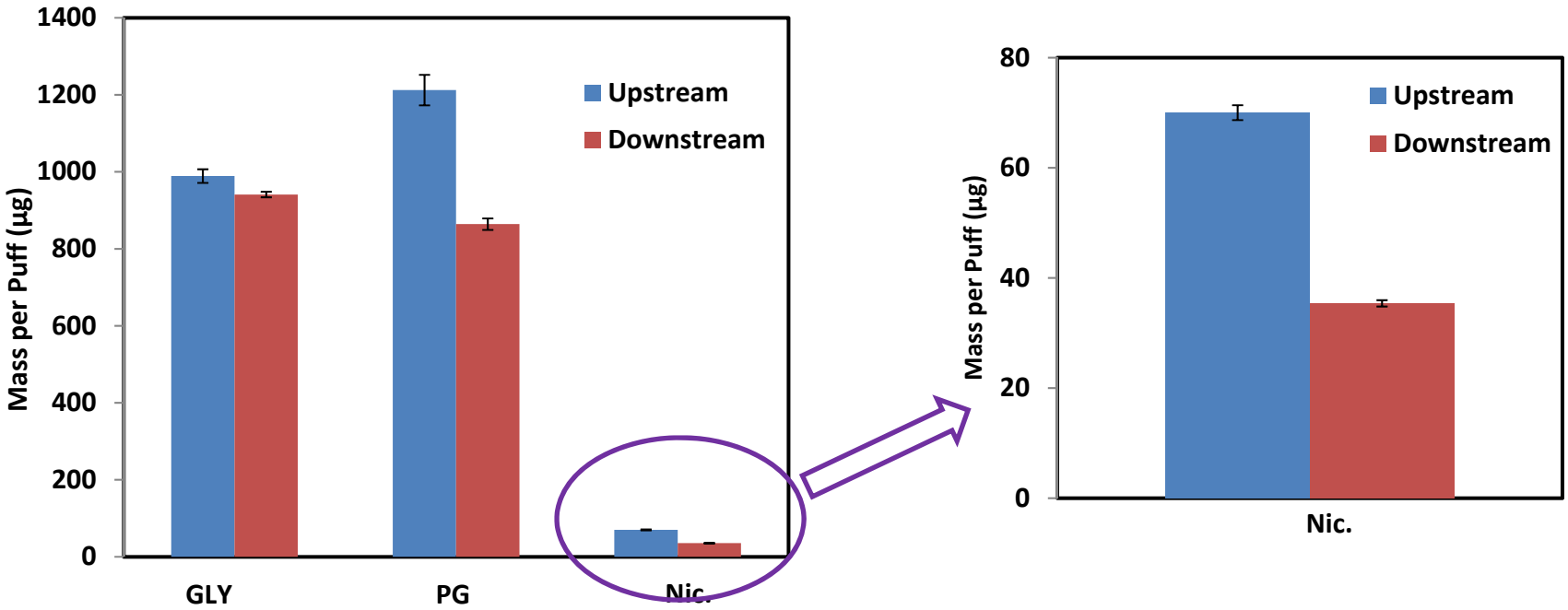
100% PG



100% Gly

Chemical Analysis

Results – Chemical Analysis (wet)



2.5% NBW, 15% water, 49.5% PG/Gly 33%

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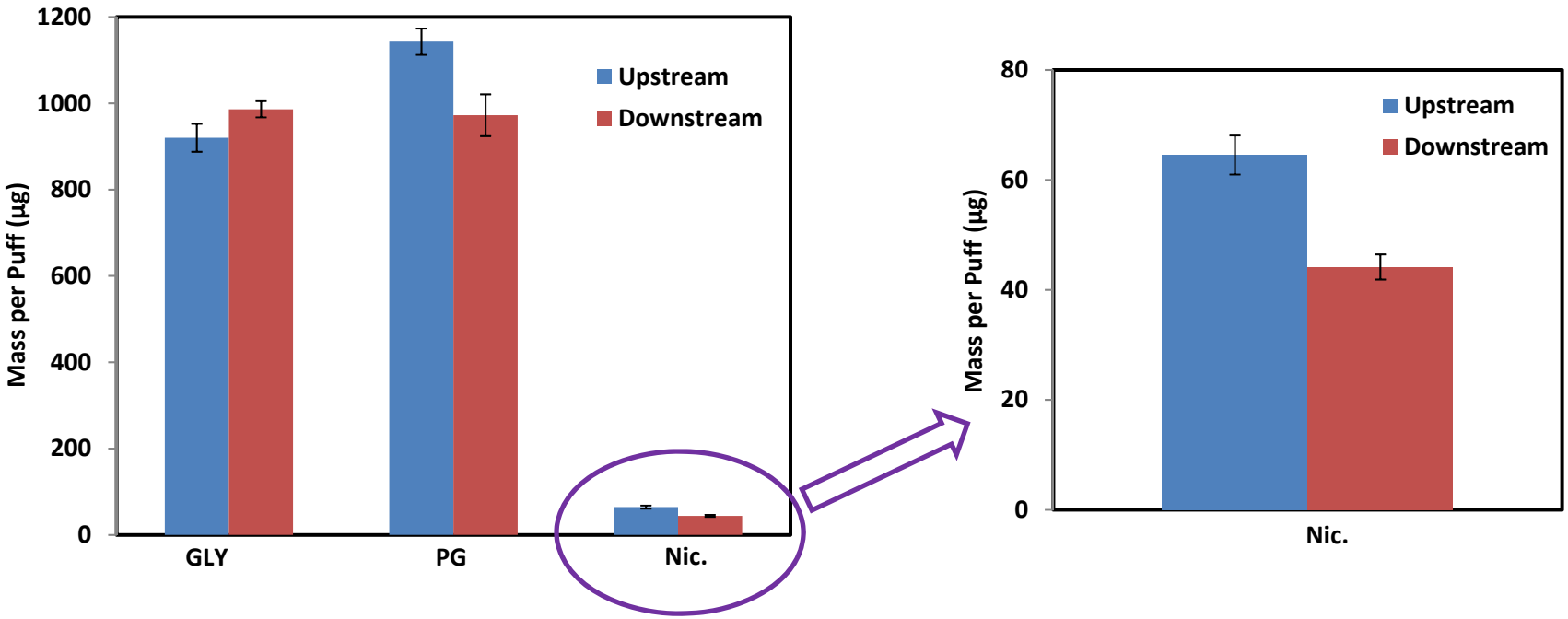
Results – Chemical Analysis (dry)



2.5% NBW, 15% water, 49.5% PG/Gly 33%

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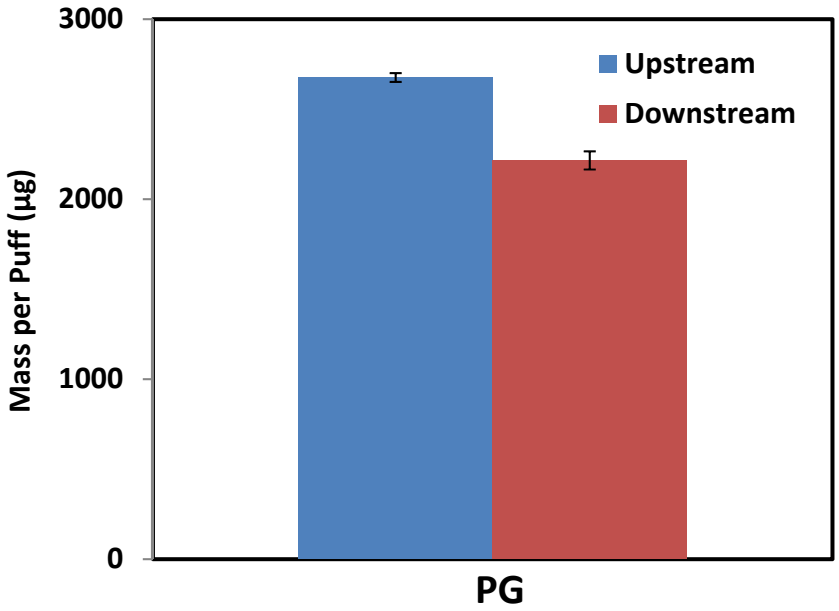
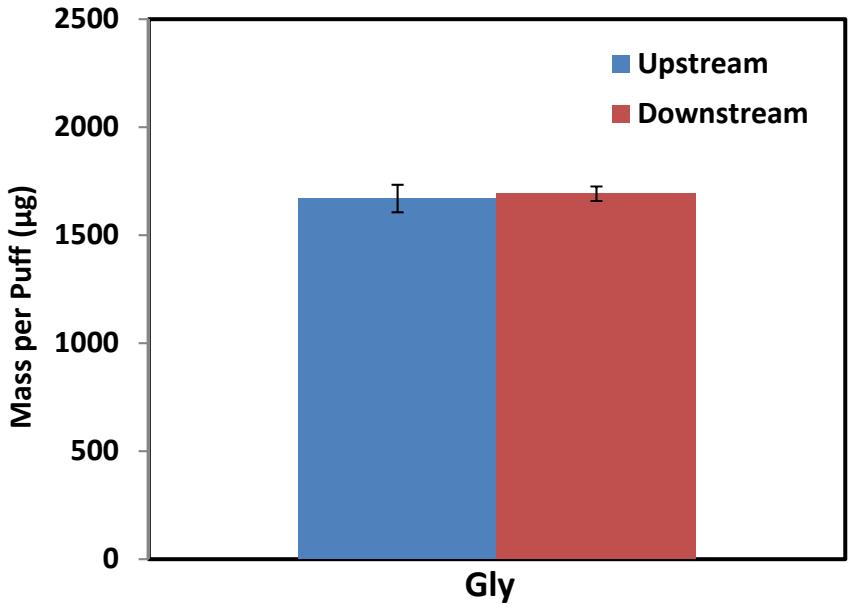
Results – Chemical Analysis (wet)



100% PG



100% Gly

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Summary

- A physical model mimicking the human respiratory tract was developed.
- High relative humidity resulted in hydroscopic growth of particles, which depended on the composition of e-cig aerosols.
- The loss of PG and Nicotine is higher than the loss of Glycerin.

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Thank You!