



Course ID and Title: ASTE-599, Contamination Control of Space Systems and Planetary Protection

Units: 3

Term—Day—Time: Spring 2025, Wednesday 12:00 – 2:50 pm

Location: RTH 115

Instructor: Dr. Lubos Brieda

Office: OHE 530J

Office Hours: TBD

Contact Info: brieda@usc.edu

Teaching Assistant: TBD

Office: TBD

Office Hours: TBD

Contact Info: TBD

Course Description

The familiar “new car” smell arises from the outgassing of volatile gases from plastic (organic) materials making up the car interior. A similar process is present on spacecraft where molecular contaminants diffuse out of electronic boards or adhesives, and can subsequently deposit on sensitive surfaces such as telescope lenses or thermal surfaces, leading to degraded mission performance. Water vapor is of concern on cryogenic missions. Other contaminant types include dust particulates, lunar regolith, and biological burden. This course provides a comprehensive review of topics related to contamination control and planetary protection relevant to astronautical engineering. Students will learn about contaminant characterization and its impact on spacecraft components, material science and polymer chemistry, contaminant sources, mitigation strategies, contamination budgets and I&T cleanliness requirements, purging, thermal vacuum bakeouts, launch site processing, and contamination transport analysis.

Learning Objectives

By the end of this course, students will be able to: understand common sources of molecular and particulate contaminants and their impact on space missions, develop contamination control plans, characterize contamination budget from beginning to end of life, analyze QCM measurements and tapelift data, develop bakeout, planetary protection, and purge requirements, and be able to perform a simple numerical simulation of molecular outgassing.

Prerequisite(s): ASTE-520

Co-Requisite(s): N/A

Concurrent Enrollment: N/A

Recommended Preparation: ASTE-535

Course Notes

The course will use Letter grading. Brightspace will be used to distribute course material (slides) and will also be used to collect student assignments. The class will be offered in a Zoom-enabled classroom, allowing for remote participation.

Technological Proficiency and Hardware/Software Required

Students are expected to be proficient with common office productivity tools such as Microsoft Office. Additionally, students will be expected to perform a numerical simulation of molecular outgassing using an instructor provided simulation program. Students will be given the option to install the software on their computers, but will also be able to run it using university a remote computing environment (such as USC Discovery HPC system). Simulation results will be visualized using the freeware program Paraview.

Required Readings and Supplementary Materials

- 1) Class Notes and Handouts
- 2) Tribble, A., *Fundamentals of Contamination Control*, SPIE, 2000

Optional Readings and Supplementary Materials

N/A

Description and Assessment of Assignments

Course grade will be based on four categories: homework assignments, mini projects, take home quizzes, and a final exam. Homework assignments will be assigned weekly and will be due the following week. There will also be 4 “mini projects” that will involve following steps to complete a specific assignment. The envisioned topics include the development of a contamination control budget, analysis of bakeout and tapelift data, development of pre-launch cleanliness verification procedures, and performing a numerical simulation of molecular outgassing. There will also be 4 take home open-book quizzes consisting of approximately 10 true/false, multiple choice, matching, or short answer / calculation questions on topics covered since the prior quiz. The final exam will be comprehensive, and will utilize questions similar to those encountered in prior assignments.

Participation

Participation will not be graded, however students are expected to participate in the class by attending lectures live or watching the Zoom recordings.

Grading Breakdown

Assessment Tool (assignments)	% of Grade
Homework	40
Mini projects	20
Quizzes	20
Final Exam	20
TOTAL	100%

Grading Scale

Course final grades will be determined using the following scale:

Letter grade	Corresponding numerical point range
A	95-100
A-	90-94
B+	87-89
B	83-86
B-	80-82
C+	77-79
C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 and below

Assignment Submission Policy

Assignments are to be submitted to the online learning platform in the form of a .pdf report along with any pertinent attachments. Homework assignments and quizzes are due at the start of the following lecture, unless noted otherwise. Mini-projects will typically be due 2 weeks after assignment. A 10% deduction will be applied to every day the submission is late, with submissions more than 9 days late receiving no credit. Students are encouraged to collaborate on the homework assignments and the projects, however each submission must be individual.

Grading Timeline

Assignments will be graded in a reasonable time frame, usually within two weeks of submission.

Instructor Bio

Dr. Brieda has over 10 years of experience working as a contamination control engineer, first on site at NASA Goddard Space Flight Center, and then by providing support through his company Particle In Cell Consulting LLC. He has worked on many NASA missions, including Magnetospheric Multiscale (MMS), the James Webb Space Telescope (JWST), Geostationary Operational Environmental Satellite - R Series (GOES-R), Restore-L, GEMS, TESS, STPSat-6, and many others. He is currently leading the contamination analysis for the JHU/APL Dragonfly mission which will fly a rotorcraft rover on Saturn Moon's Titan. His additional past work experience includes the role of a research engineer at the Air Force Research Lab. At USC, he also teaches classes on scientific computing and computational plasma physics, ASTE-404 and ASTE-546, and also co-advises the undergraduate student club ASPEN.

Tentative Course Schedule

Week	Topics/Daily Activities	Deliverables
1	Introduction to contamination control and planetary protection, contamination sources	
2	System drivers - sensitive surfaces, impact of contamination on optical and thermal properties, impact of particulates on scatter, mechanical systems, discharges	HW1
3	Contamination control plans, I&T + operation contamination budget	HW2
4	Cleanrooms, gowning protocols, inspection, bagging, cleaning procedures	HW3
5	Contamination quantification: rinses, tapelifts, particle counters	HW4, Project 1
6	Mechanical and acoustic testing, transport, bagging	HW5, Quiz 1
7	Thermal vacuum bakeouts: planning, pumps, thermal control surfaces, instrumentation, scavenger plates / coldfingers, QCM data analysis. <i>Possible visit to on-campus vacuum chamber facility.</i>	HW6
8	Dust transport: clean rooms, launch vehicle ECS flow, articulation	HW7
9	Planetary protection mitigation, baking, cleaning	HW8, Project 2
10	Purge System Design	HW9, Quiz 2
11	Launch site processing, launch particulation	HW10, Project 3
12	Cryogenic considerations: outgassing of water, ice surface formation	HW11
13	Chemistry - material sources, outgassing, surface desorption	HW12, Quiz 3
14	Molecular transport modeling	HW13
15	Spacecraft charging, photoionization, electrostatic return, lunar regolith, orbital debris	HW14, Project 4
FINAL	Refer to the USC <i>Schedule of Classes</i> at classes.usc.edu	HW15, Quiz 4, Final

Academic Integrity

The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct is in contrast to the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

This course will follow the expectations for academic integrity as stated in the [USC Student Handbook](#). All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

Academic dishonesty has a far-reaching impact and is considered a serious offense against the university. Violations will result in a grade penalty, such as a failing grade on the assignment or in the course, and disciplinary action from the university itself, such as suspension or even expulsion.

For more information about academic integrity see the [student handbook](#) or the [Office of Academic Integrity's website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment or what information requires citation and/or attribution.

In this course, you may utilize artificial intelligence (AI)-powered programs to help you with assignments unless the assignments specifically prohibits such use. The use of AI systems is not authorized on quizzes and examinations. You should also be aware that AI text generation tools may present incorrect information, biased responses, and incomplete analyses; thus they are not yet prepared to produce text that meets the standards of this course. To adhere to our university values, you must cite any AI-generated material (e.g., text, images, etc.) included or referenced in your work and provide the prompts used to generate the content. Using an AI tool to generate content without proper attribution will be treated as plagiarism and reported to the Office of Academic Integrity. Please review the instructions in each assignment for more details on how and when to use AI Generators for your submissions.

If found responsible for an academic violation, students may be assigned university outcomes, such as suspension or expulsion from the university, and grade penalties, such as an "F" grade on the assignment, exam, and/or in the course.

Course Content Distribution and Synchronous Session Recordings Policies

USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to

students or in any way had been displayed for use in relation to the class, whether obtained in class, via email, on the internet, or via any other media. Distributing course material without the instructor's permission will be presumed to be an intentional act to facilitate or enable academic dishonesty and is strictly prohibited. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Course Evaluations

Course evaluation occurs at the end of the semester university-wide. It is an important review of students' experience in the class. The process and intent of the end-of-semester evaluation should be provided. In addition, a mid-semester evaluation is recommended practice for early course correction. [Contact CET](#) for support in creating a mid-semester evaluation.

Statement on University Academic and Support Systems

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. [The Office of Student Accessibility Services](#) (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Student Financial Aid and Satisfactory Academic Progress:

To be eligible for certain kinds of financial aid, students are required to maintain Satisfactory Academic Progress (SAP) toward their degree objectives. Visit the [Financial Aid Office webpage](#) for [undergraduate-](#) and [graduate-level](#) SAP eligibility requirements and the appeals process.

Support Systems:

[Counseling and Mental Health](#) - (213) 740-9355 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

[988 Suicide and Crisis Lifeline](#) - 988 for both calls and text messages – 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline consists of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

[Relationship and Sexual Violence Prevention Services \(RSVP\)](#) - (213) 740-9355(WELL) – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

[Office for Equity, Equal Opportunity, and Title IX \(EEO-TIX\)](#) - (213) 740-5086

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

[Reporting Incidents of Bias or Harassment](#) - (213) 740-2500

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

[The Office of Student Accessibility Services \(OSAS\)](#) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

[USC Campus Support and Intervention](#) - (213) 740-0411

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

[Diversity, Equity and Inclusion](#) - (213) 740-2101

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

[USC Emergency](#) - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

[USC Department of Public Safety](#) - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call

Non-emergency assistance or information.

[Office of the Ombuds](#) - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

[Occupational Therapy Faculty Practice](#) - (323) 442-2850 or otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.