Collated feedback from Workshop 1

How does the plasma contribute to enhanced interaction between species in multiphase media?

is it primarily by: (i) providing a source of free charge on surfaces; (ii) ensuring maximal surface area for reactions (say by Coulomb repulsion); (iii) generating radicals and excited states that can enhance reactivity?

- Is the role of synergistic processes of neutrals and electric fields etc significant on influencing the interfacial processes?
- enhanced charging of isolated surfaces changing local chemistry; bond breaking, new species, radicals - ion bombardment.
- How is charge bound to the surface? What processes affect this, and what lifetime?
- reactivity often changed but not understood, e.g. formation of h2O2 can be much higher in charged droplets.
- in liquid, polarizability can be more important than dielectric behaviour.
- plasma provides reactive species, the plasma might generate a gas in a liquid which leads to turbulence enhanced surface area.
- Plasma could potentially aid in biological research concerning biofilms (e.g. dealing with antibiotic-resistant bacteria) and cancer research (e.g. tumor drug delivery).
- Plasma can also provide a different (often better!) delivery of energy to the system, although there is an issue of selectivity.
- It forms particular structures that can't otherwise be formed in other systems.
- Surface electric field can enhance interactions in all phases.
- Synergies between particles, fields, coming from plasma into solid.
- Is there the concept of an electron distribution function in a liquid?
- How many phases should we consider at one time? Controlled by physical width of transition region? Need to consider collisional length scales within transition region?

What investigations can help identify and optimise the relevant processes?

Where are the tantalising but unexplored edges of the field? What do we need (equipment, models, insight) to venture there?

- The aerosol/colloidal chemistry community has a plethora of techniques and studies that may influence the direction of multiphase media studies with plasmas. Diagnostics for penetration depths and charging are realistic goals for the intermediate future.
- find out what the basic processes are for charge attachment and lifetimes - theory and experiment. Cross-section experiment
- Need enhanced source data (rate coeffts, covering regimes of interest) Atypical chemical pathways - enhanced spectroscopic investigation?
- some people have femtosecond lasers that can work with people who dont to obtain high speed lasers (fast enough that eg bubbles are stationary) resolve species e.g. oh crossing a boundary.
- Is there a way for modellers to give wishlist for diagnostics for what diagnostic people can measure with their equipment?

- do we have a robust repeatable plasma (benchmark)
- we don’t have benchmark models in much of plasma physics let alone multiphase physics to compare models to expt.
- Is there a proxy measurement, e.g. impedance that tells us something about the multiphase such as bubbles forming?
- These should be application-driven. Perhaps it would be worth-while to have a priority list of the fundamental data we need (probably tied to specific application).
- There are procedures for liquids but no in interface with plasmas – so not fully valid here.
- New diagnostic methods are required.
- Need data for modelling e.g. cross-sections, rate coefficients and to know regions of applicability, etc.

What other relevant points should be made?

Are there important issues in this topic that are not covered in the answers above?

- A coherent model (or several) for charging of multiphase media would be desirable and ablation of metals by lasers: do these count as multiphase media?
- laser-surface interactions are a particular aspect. Reach out to other communities with different languages, but same underlying principles
- Measurements often very hard, either lack of equipment or impossible completely.
- Peoples experiments are all different and can't be compared if even a small difference changes the key parameters. All tools made for semiconductor industry, even the same design, perform differently and those are as consistent as they get.
- is there a question we can answer that will get us into Nature?
- We need to manage the expectations we have of each other when embarking on new, multi-disciplinary projects, i.e. sometimes (or at different points of the project lifetime) Plasma Physics may be service-providers to other disciplines then service-receivers. There is still not enough clear communication among different disciplines and too much compartmentalisation even within the Plasma community itself.
- Formation of very small-scale structures on top of larger ones.
- Fundamental data for modelling so that we can optimise processes e.g. cross-sections etc.
- To find financial support: contextualise and find applications to get funding.
- Modelling approach: hybrid, fluid-kinetic modelling. What are the cross sections and rate coefficients? Problematic due to inclusion of particles (solid) and non-equilibrium distribution functions. How to measure e distribution function?
- At what scale do the macroscopic properties cease to be an appropriate language to discuss the system