



HAL
open science

Plasma-water interfaces for applications in nanomaterials synthesis

David Z Pai

► **To cite this version:**

David Z Pai. Plasma-water interfaces for applications in nanomaterials synthesis. Annual Meeting of the Electrostatics Society of America, Jun 2021, Norman (Oklahoma), United States. hal-04488776

HAL Id: hal-04488776

<https://hal.science/hal-04488776>

Submitted on 4 Mar 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Plasma-water interfaces for applications in nanomaterials synthesis

David Z. Pai

Laboratoire de Physique des Plasmas, Ecole Polytechnique, Route de Saclay, 91128 Palaiseau, France

The plasma-water interfacial region is believed to play an important role in applications involving plasma-activated water (PAW), such as graphene quantum dot synthesis in aqueous solution using a DC microplasma electrochemical reactor [1,2]. As a simplified test case, we experimentally investigate the interfacial region using in-situ Raman microspectroscopy with a spatial resolution as high as several tens of microns. The plasma reactor of choice is a DC glow generated in ambient air using a pin electrode placed above an optical cell filled with deionized water. First, we will examine the solvent itself, tracking the –OH stretch, bend, and librational bands of water. In particular, the –OH stretch band experiences increasing intensity of the fundamental frequency distribution around 3400 – 3500 cm^{-1} , which is weakly coupled to other hydrogen bonds. The peak around 3200 – 3300 cm^{-1} , resulting from intermolecular coupling and strong hydrogen bonding, experiences decreasing intensity. We will discuss both rapid and gradual changes to the Raman spectra over the course of plasma treatment, as well as the reversibility of these changes once the plasma is switched off. The effect of depth below the plasma-water interface will also be discussed: the changes to the Raman spectra become more pronounced as the detection volume approaches the interface. Second, we track the concentration of the PAW species H_2O_2 and NO_3^- via their calibrated Raman spectra. Again, the careful control of the detection volume reveals the presence of a near-interface region whose chemistry is distinct from that in the bulk liquid.

Acknowledgments

Financial support: ANR grants ANR-15-CE06-0007-01 and ANR-11-LABX-0017-01.

References

- [1] Orrière, T., Kurniawan, D., Chang, Y. C., Pai, D. Z., & Chiang, W. H. (2020). *Nanotechnology* 31 (485001).
- [2] Yang, J. S., Pai, D. Z., & Chiang, W. H. (2019). *Carbon*, 153, 315-319.