# Plasma Polymerized Tetraglyme Shows Improved Blood Compatibility

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**Statement of Purpose:** The realization of small-scale biomedical devices is closely related to the non-fouling properties of the exposed surfaces throughout the device. In particular, thrombus formation is a significant problem for blood-contacting biomedical devices. Since the interactions that lead to thrombus formation occur at the biomaterial/blood interface, appropriate surface modification methods will be beneficial in improving the blood compatibility of biomaterials for devices. Polyethylene Oxide (PEO) surfaces have great promise because they are unreactive toward proteins, cells, and other biological components[1]. In this work, we relate the surface chemistry of plasma-polymerized of tetraethylene glycol dimethyl ether (tetraglyme) to the ability of these surfaces to improve the blood compatibility of silicon-based surfaces.

**Methods:** Plasma polymerization (PP) is a method in which gaseous monomers, excited by a plasma, precipitate onto substrates as highly cross-linked layers. During PP, tetraglyme monomers contained in the plasma discharge undergo a large degree of molecular ionization, fragmentation, and rearrangement. The degree of cross-linking can be controlled through plasma-processing parameters such as pressure, exposure time, and power input.

A radio frequency glow discharge (13.56 MHz) was used to plasma-polymerize tetraglyme onto 1 $cm^2$ silicon substrates. To prepare for the PP process, tetraglyme liquid is first degassed and evaporated. Tetraglyme vapors enter the plasma processing chamber with the assistance of an argon carrier gas. During the plasma polymerization process, the tetraglyme liquid reservoir is heated to $110^0$C to supply a constant monomer flow rate. A number of plasma-deposited coatings were prepared at input powers of 200 W and 800 W, exposure times of 10 and 20 minutes, and pressures of 100 mTorr and 200 mTorr. After the PP process, the samples were washed and soaked in methanol overnight until XPS was preformed.

To determine if PP tetraglyme films alter blood compatibility, samples were exposed to heparinized-human blood. Twenty ml of blood was obtained by a standard venipuncture technique from a healthy human donor. The blood was stored at $37^0$C for 20 minutes until being placed in a Petri dish with the sample surface. The treated and untreated samples were exposed to blood with rocking at $37^0$C for one hour. After blood exposure, fixation, and dehydration, all samples were critical-point dried and then prepared for SEM imaging.

**Results/Discussion:** As shown from the XPS data below (Figures 1 and 2), tetraglyme coatings processed at 100 mTorr show an ether peak and multiple hydrocarbon peaks, signifying a high degree of cross-linking. In contrast, tetraglyme coatings processed at 200 mTorr show a low degree of cross-linking. Figure 3 shows the relative number of blood platelets adhering to each surface. The tetraglyme processed at 200 mTorr had significantly fewer platelets adhering to the surface than the tetraglyme surface processed at 100 mTorr and the control.

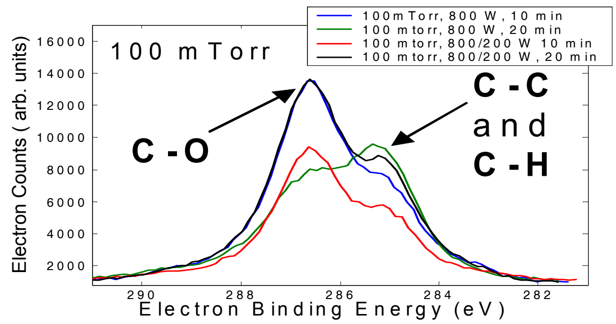


***Figure 1:*** *The XPS data of tetraglyme processed at 100 mTorr.*

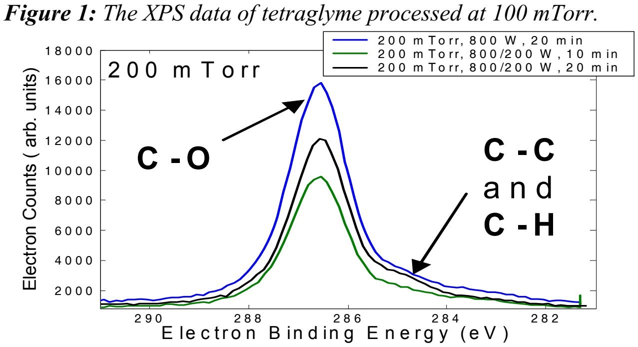


***Figure 2:*** *The XPS data of tetraglyme processed at 200 mTorr.*

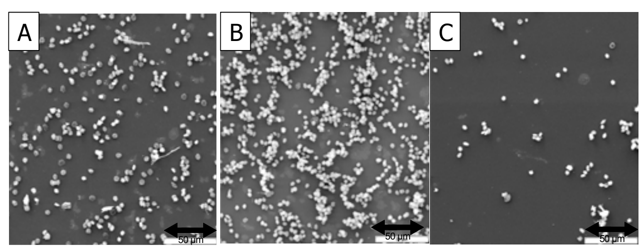


***Figure 3:*** *SEM images of A.) control, untreated silicon, B.) tetraglyme processed at 100 mTorr, and C.) tetraglyme processed at 200 mTorr.*

**Conclusions:** This study demonstrates that pressure has a large effect on the surface chemistry of PP tetraglyme films. These chemical changes greatly influence the resistance of the surface to human-blood platelets and cell adhesion, thus altering blood compatibility.

**References:**

[1] Shen M. J. Biomat. Sci. 2002, 13: 367-390