Characterizing the stability of poly-ethylene glycol coatings as a function of humidity and temperature

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In recent years there has been a growing use of poly-ethylene glycol (PEG) in biomedical research and development. PEG is a high molecular weight molecule, commonly used in pharmaceutical applications such as colonic lavage systems [1] due to its inert properties. PEG can also be used as an anti-fouling coating which can be selectively degraded to enable patterning of cells into predetermined shapes. We and others use PEG to create micropatterns for cell culture to study the effect of cell shape on cell mechanics [2] [3]. PEG has one significant setback; it tends to degrade and lose its antifouling property over time. Despite the prevalence of PEG in industry and research, its stability as an anti-fouling surface coating remains unclear.

This study aims to characterize the rate of degradation of PEG coupled with a succinimidyl valerate (SVA) ester attached to glass surfaces via covalent bonds to poly-l-lysine as a function of humidity and temperature. We use two methods to characterize PEG degradation. First, we use fluorescently tagged gelatin to backfill the regions where the PEG has degraded and measure the intensity of the fluorescent signal, which is correlated to the degree of degradation. In the second method, we use atomic force microscopy to visualize the nanoscale changes to PEG-coated glass surfaces that accompany its degradation. Our preliminary results suggest that optimal storage conditions for PEG-coated glass are phosphate buffer solution (PBS) at 4 °C (Fig. 1). We also observed spontaneous pattern formation in PEG-coated surfaces dried after PBS incubation, which can potentially be harnessed for patterning cells into complex geometries without the use of photolithography (Fig. 2). The results of this study will inform our understanding of the mechanisms by which PEG degrades as a function of environmental conditions, enable longer-term storage of PEG-treated and micropatterned surfaces, and ultimately contribute to the field of mechanobiology.

[1] J.K. Aronson. Glycols. In Meyler's Side Effects of Drugs (Sixteenth Edi- tion), pages 567–570. Elsevier, Oxford, sixteenth edition edition, 2016.

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[3] L. Engel, C.G. Vasquez, E.A. Montabana, B.M. Sow, M.P. Walkiewicz, W.I. Weis, and A.R. Dunn. Journal of structural biology, 213(4):107791, 2021.

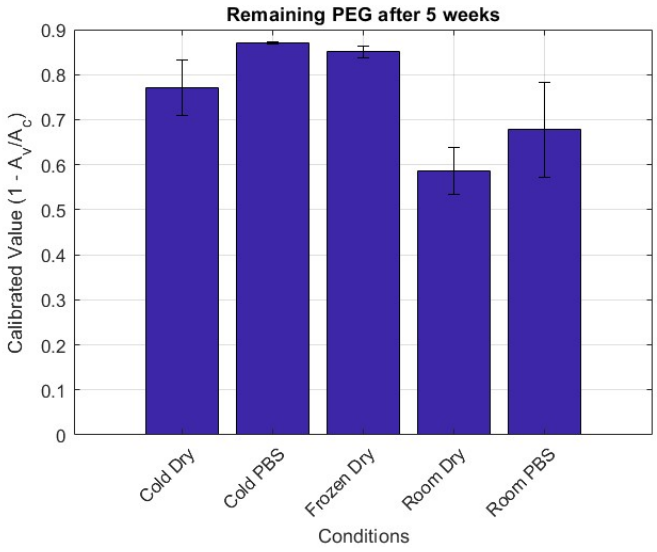

Figure 1: The amount of PEG that remains on the glass coverslip as a function of temperature (cold=4 °C, frozen = -20 °C, room = 25 °C) and humidity (wet vs. dry) after 5 weeks. N=6. Error bars represent standard deviation.

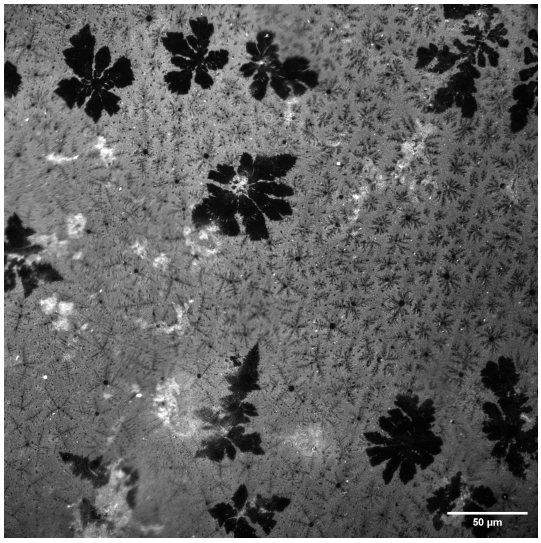

Figure 2: Micrograph of sample left to dry at room temperature for five weeks before being rinsed, incubated in fluorescently tagged gelatin (white), and imaged at 40x with a fluorescent microscope. Black shapes indicate regions where PEG is intact.