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Mechanical performance and chemical characterization of elastomers subjected to high pressure for applications in underwater soft robotics

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Soft robots can deform to adapt to the shape of their surroundings, making them invaluable for asset inspection sub-sea. Thermoplastic elastomers, known for their long-range reversible elasticity, are a class of materials well-suited for such applications. This study investigates the mechanical and chemical behavior of various thermoplastic elastomers (TPE, TPU, and TPV) under hyperbaric chamber conditions simulating high-pressure underwater environments. Tensile testing reveals that while some materials maintain stable mechanical properties, others exhibit significant variations in maximum tension and rupture deformation. Notably, TPU 5125 and TPV 6406 maintain mechanical behavior similar to controls. Additionally, FTIR analysis in TPV 6006 shows absorption bands in 1722, 1375, and 1118 cm⁻¹, suggesting potential oxidation promoted by treated water interaction. All the other samples present chemical stability. These findings emphasize the importance of material selection for high-pressure underwater applications and underscore the need for further research on environmental effects on elastomer performance.