# Chemical Modification and Synthesis of a Polysiloxane Composite for Enhanced Performance in Dielectric Elastomer Transducers

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Biomedical devices for personalized health monitoring are crucial for early disease detection and therapy, yet current devices are rigid and uncomfortable, causing issues with long-term wearability. Soft skin-like sensors and soft robotic muscles known as Dielectric Elastomer Transducers (DET), which are commonly composed of polydimethylsiloxane (PDMS), exhibit low performance, instability, and energy inefficiency due to the suboptimal dielectric properties and stiffness of PDMS. Existing methods of modifying PDMS with extrinsically-formed fillers face a longstanding tradeoff between permittivity and softness. Herein, I propose a novel chemical modification approach that functionalizes polar groups to the elastomer backbone and generates organic fillers in situ. The new method overcomes the permittivity-softness tradeoff for the first time by yielding a novel chloropropyl-functionalized silica-filled PDMS composite (CS-PDMS) with 151% higher permittivity and 74.2% softer than PDMS. This surpasses current state-of-the-art modification methods without adding toxic fillers, making this method highly valuable for maintaining material biocompatibility. Next, a DET optimization strategy reveals that CS-PDMS enhances DET performance, improving reading range by 88.28%, signal-to-noise ratio by 26.86%, and sensitivity by 277.6%. Lastly, CS-PDMS improves precision in biosensors monitoring joint movement for gait, tactile, and speech analysis, and reduces the operating voltage of artificial muscles by up to 67%. Beyond DETs, the novel CS-PDMS elastomer can enhance the performance of stretchable transistors, circuits, and antennas when applied as soft dielectric or substrate material, thereby enabling personalized health monitoring and therapy for future precision healthcare.

**Awards Won:**