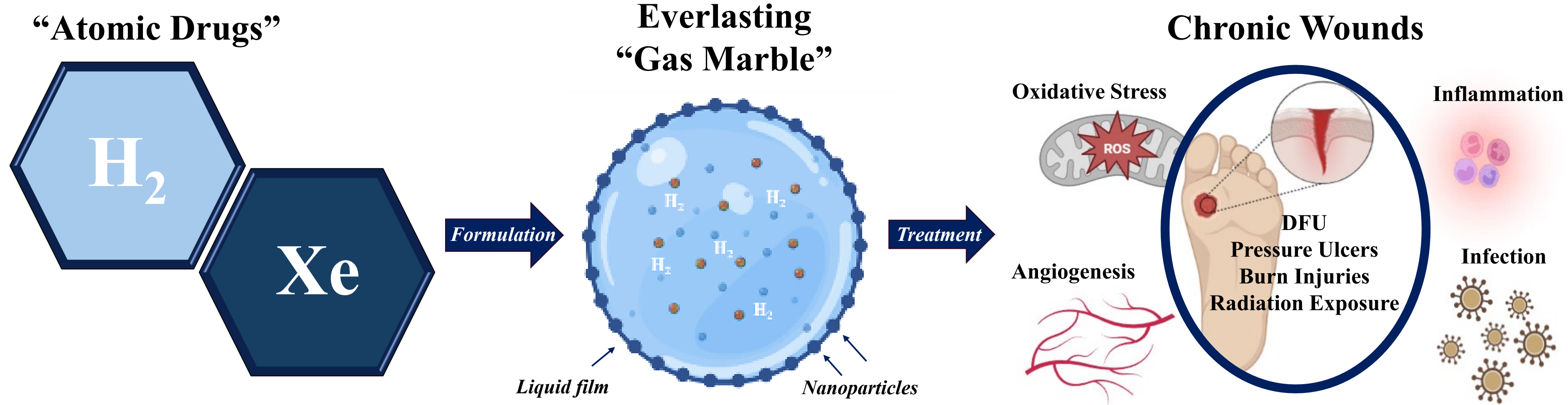


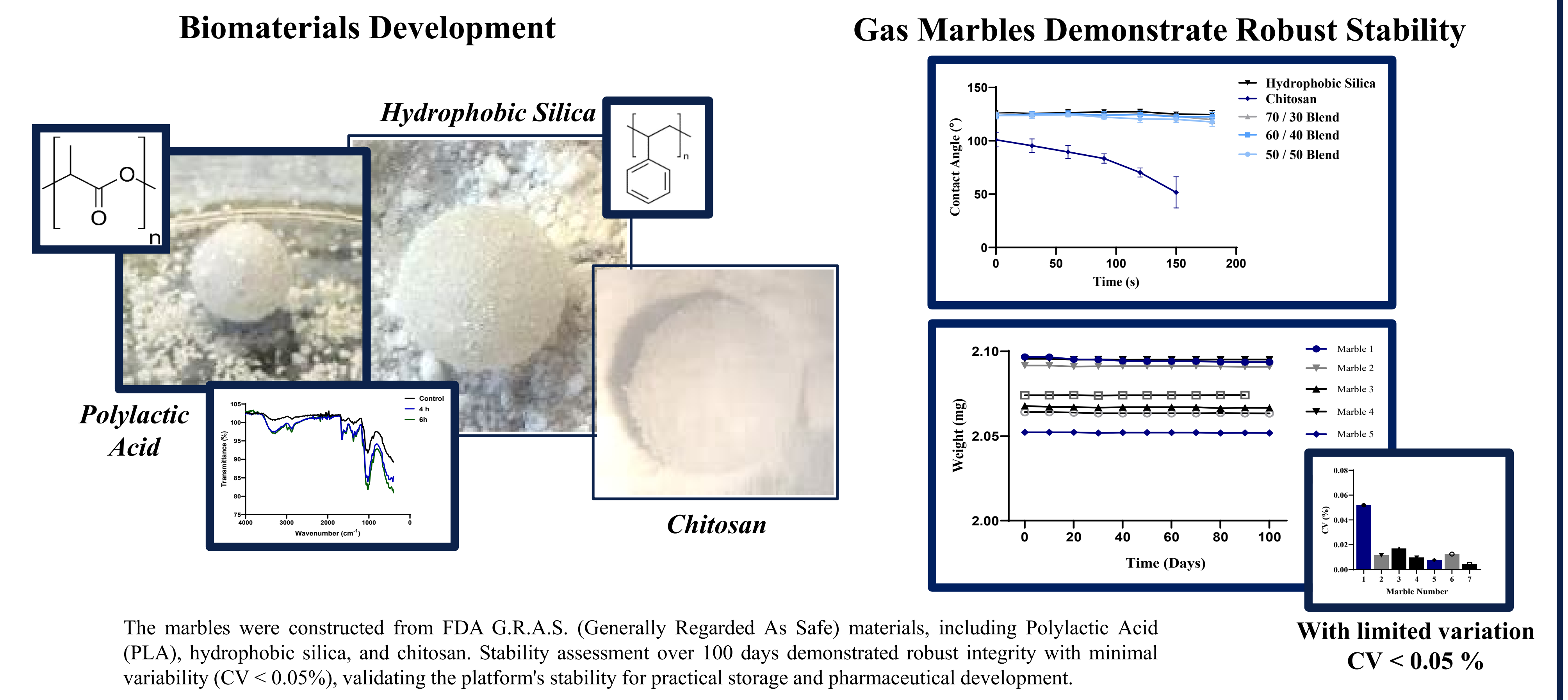
Background and Motivation



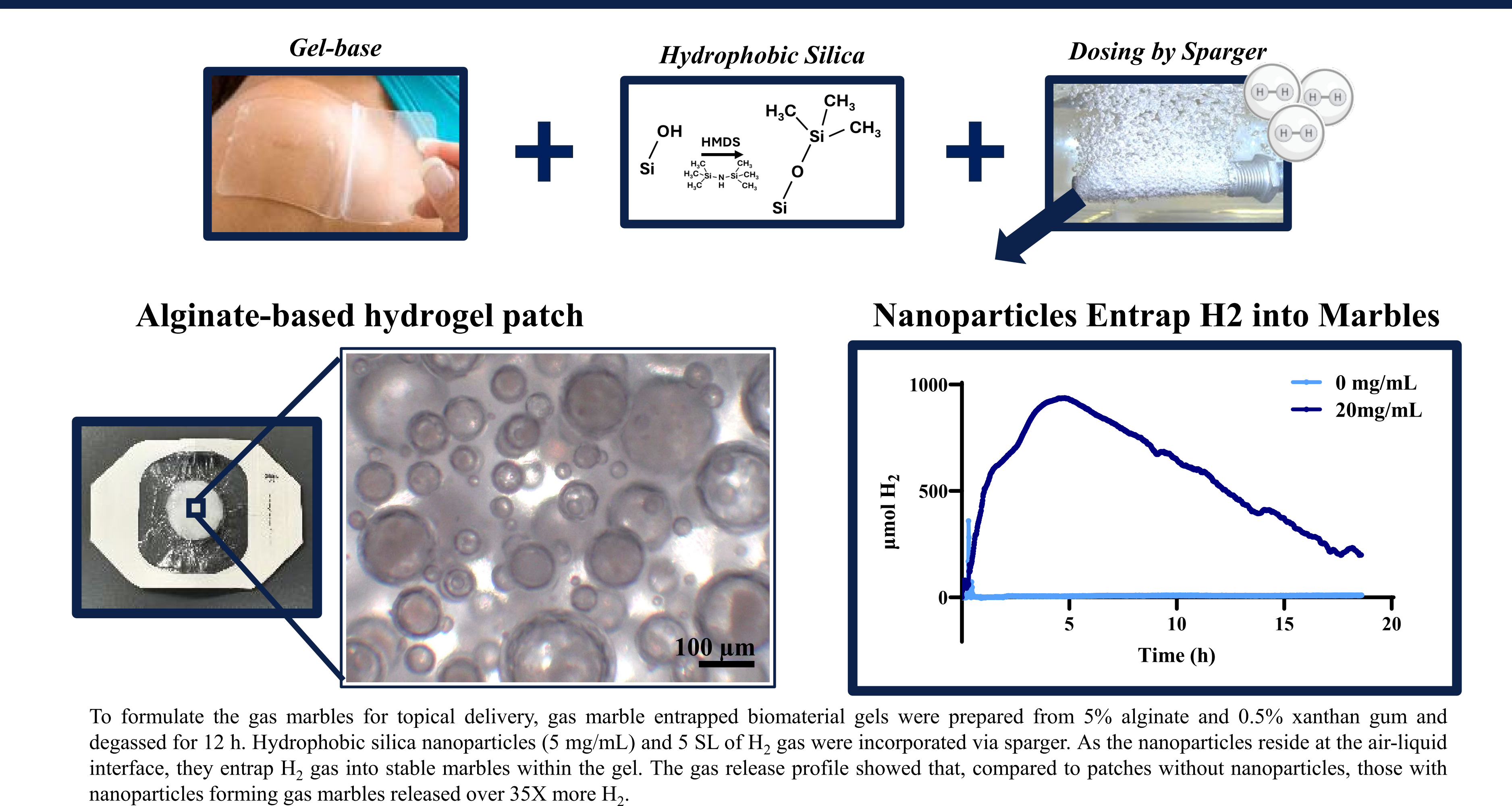
Atomic drugs, e.g., hydrogen (H₂) and Xenon (Xe), are the smallest possible therapeutic agents and have clinically demonstrated antioxidant and cytoprotective effects, respectively. But their delivery is limited to inhalation by facemask from a gas cylinder. This results in low biodistribution where the atomic drug does not accumulate in sufficient quantities at the area of need. Our research introduces a **gas marble-based atomic drug delivery system** designed to overcome these limitations. The approach relies on encapsulating therapeutic gases within a liquid film, which is fortified by biocompatible nanoparticles, creating a platform so stable that it has earned the term “gas marble”.

Chronic wounds (diabetic ulcers, burn injuries) remain a major clinical challenge due to their multifactorial pathophysiology, where persistent oxidative stress, chronic inflammation, and a high risk of infection result in stalled healing. Our technology formulates atomic drugs (H₂) into a topical patch capable of storing and delivering a therapeutically relevant gas dose directly to the wound bed. This novel method provides a localized, controlled, and accessible means to mitigate oxidative damage and resolve inflammation, addressing the core pathophysiology of chronic wounds.

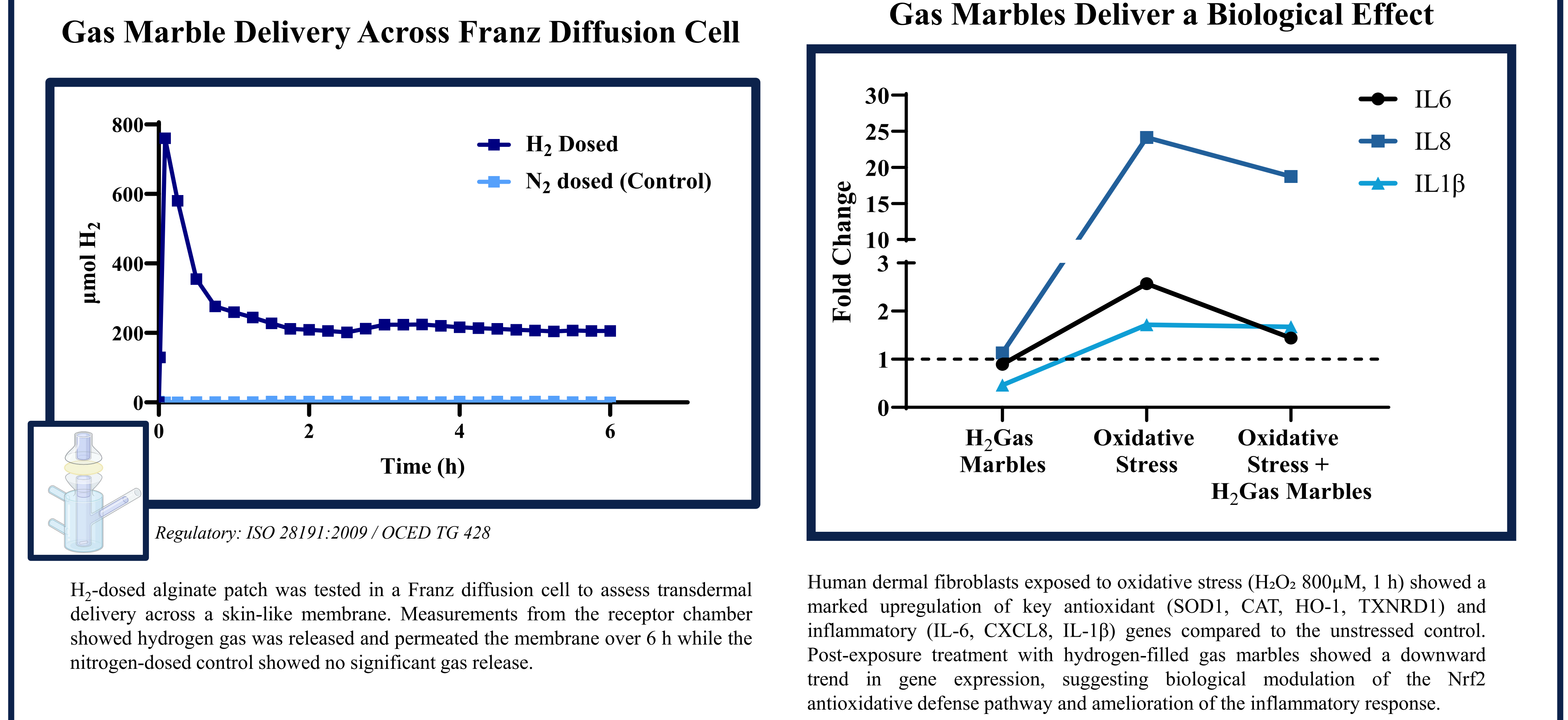
Methods: Biomaterials and Stability



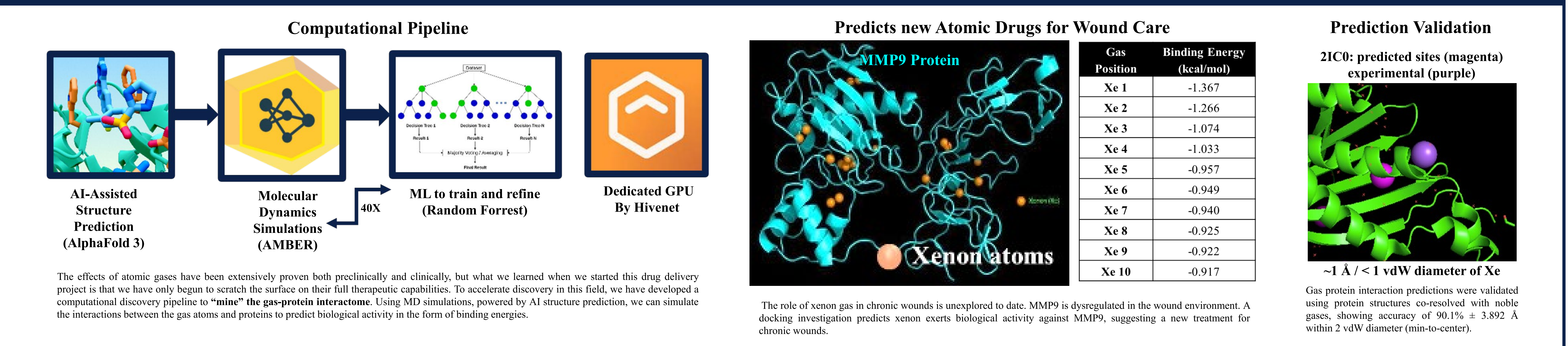
Gas Marbles Formulated for Cutaneous Delivery



Skin Permeation Dynamics of Gas Marble Delivery



AI-Driven Target Discovery



Conclusion/Future Work: We have successfully demonstrated gas marble technology as a versatile platform for the localized delivery of therapeutic atomic drugs, confirming its potential to address key pathophysiological factors in chronic wounds. Future work will advance this platform through in vivo validation of wound healing efficacy and safety in a preclinical model. We will also optimize controlled release kinetics using GC/MS analysis and engineer multi-gas combinations (e.g., H₂/NO/CO) to simultaneously target oxidative stress, angiogenesis, and infection. This strategy aims to develop a sophisticated, multi-targeted topical therapy for complex chronic wounds

Patents: PCT/U.S.2024/027766. Planet Atmosphere Gases Enwrapped into Soft Composite Nanomaterials with Medical Treatment Applications and U.S. 63/464,421 Integrated System for Discovery and Delivery of Gas Therapeutics. *Manuscript in preparation.*

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