Slow Release of Steroid via Biomolecular Glass to Address Scar Tissue Hypertrophy

Group 5

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Scar types & Prevalence

Hypertrophic

- Raised; stays within wound
- Excess collagen
- 30–70% of surgical/traumatic wounds; up to 70% in burns

Keloid

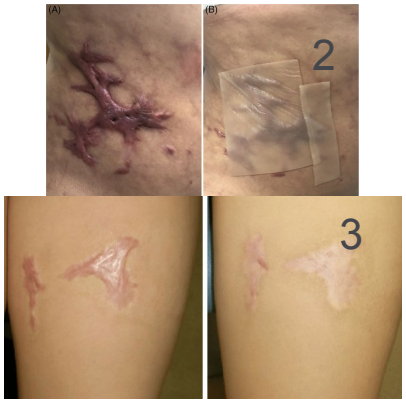
- Raised; grows beyond wound
- High recurrence
- 6–16% prevalence in darker skin types

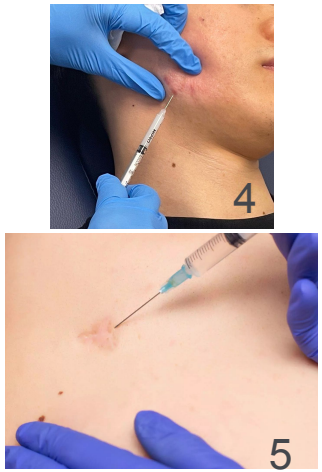
Current treatments

Topical
- Silicone gel/sheets
- Pressure therapy

Injections
- Corticosteroids
- 5-FU

Therapies/procedures
- Laser therapy
- Cryotherapy
- Surgical excision





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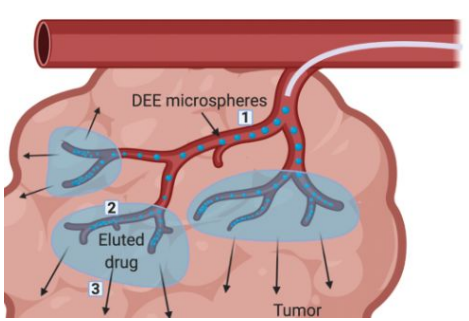
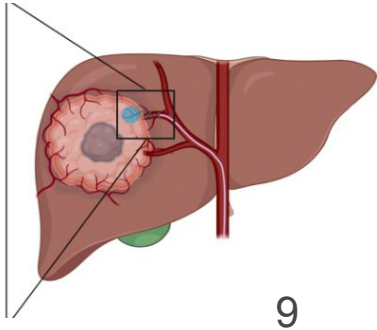
Global scar treatment ~ 32 million in 2025

Intradermal/implantable beads

- Drug-eluting microspheres used for local delivery
- Antibiotic beads applied in bone treatments
- Injectable microbeads already used in dermatology
- Supports feasibility of intradermal slow-release systems





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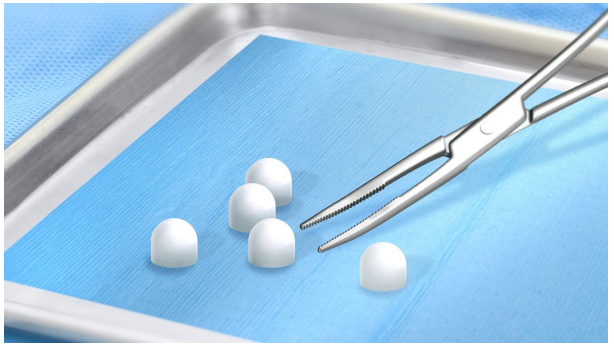

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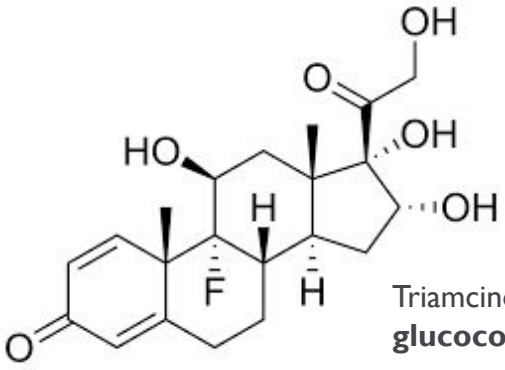
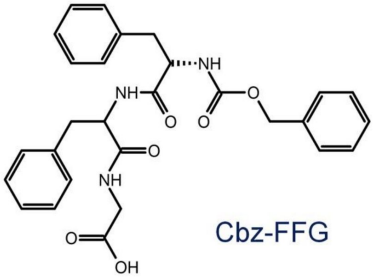
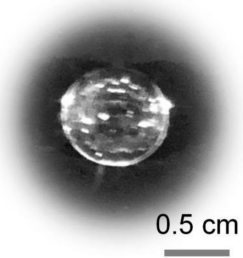
Proposal: Slow-Release Biomolecular Glass



Triamcinolone
glucocorticoid



Cbz-FFG

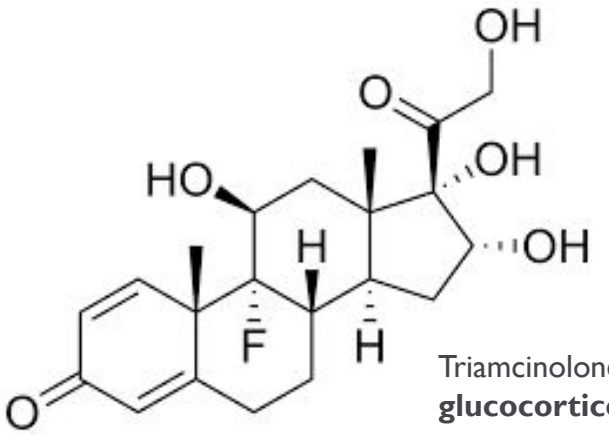


Benzyloxycarbonyl-Phe-Phe-Gly
protected tripeptide bulk phase

- **Implantable Biodegradable beads**
  local enzyme-mediated degradation allows **slow release** of incorporated drug
  - Sustained delivery of **triamcinolone** suppresses fibroblast activity, reducing pathological collagen deposition
  - **Tailored bead structure** allows for precise, local delivery and **pharmacokinetic tunability** to achieve clinically relevant timescales

Xing et al., Sci. Adv **2023**
Wikipedia

Composite bioactivity



Triamcinolone
glucocorticoid

glucocorticoid receptor activation

↓ TGF-β → ↓ myofibroblasts

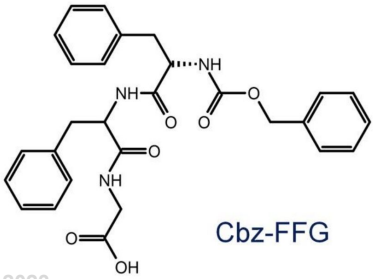
↓ GAG/collagen deposition

repression NF-κB, AP-1

$t_{1/2}$: ~4h (drug, plasma)

~36h (drug, intracellular fluid)

~<u>200h</u> (implanted bead)



Cbz-FFG

endogenous peptidases →

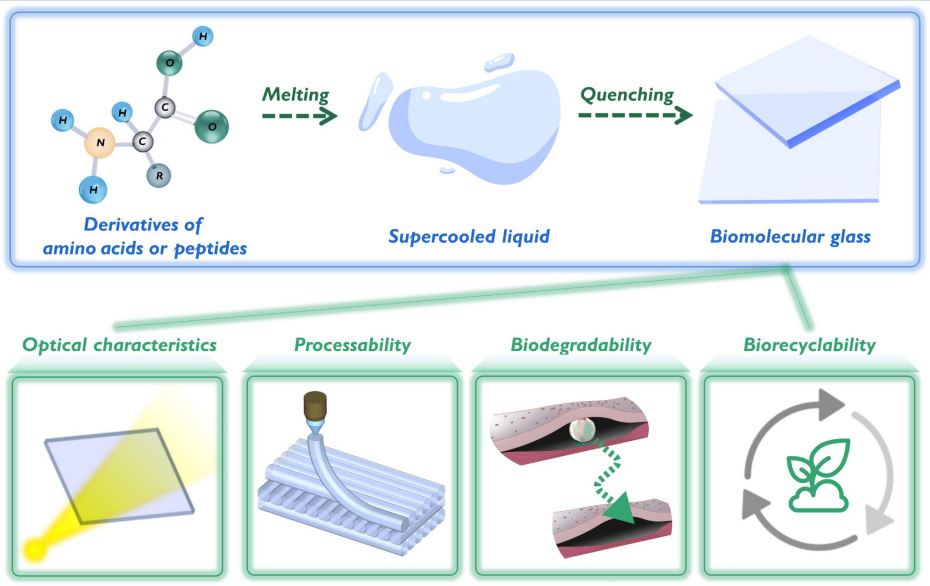
amino acids

benzyl alcohol LD_{50}: 1.2 g/kg_{rat}

CO_2

Xing et al., Sci. Adv **2023**
Wikipedia

Bead Synthesis



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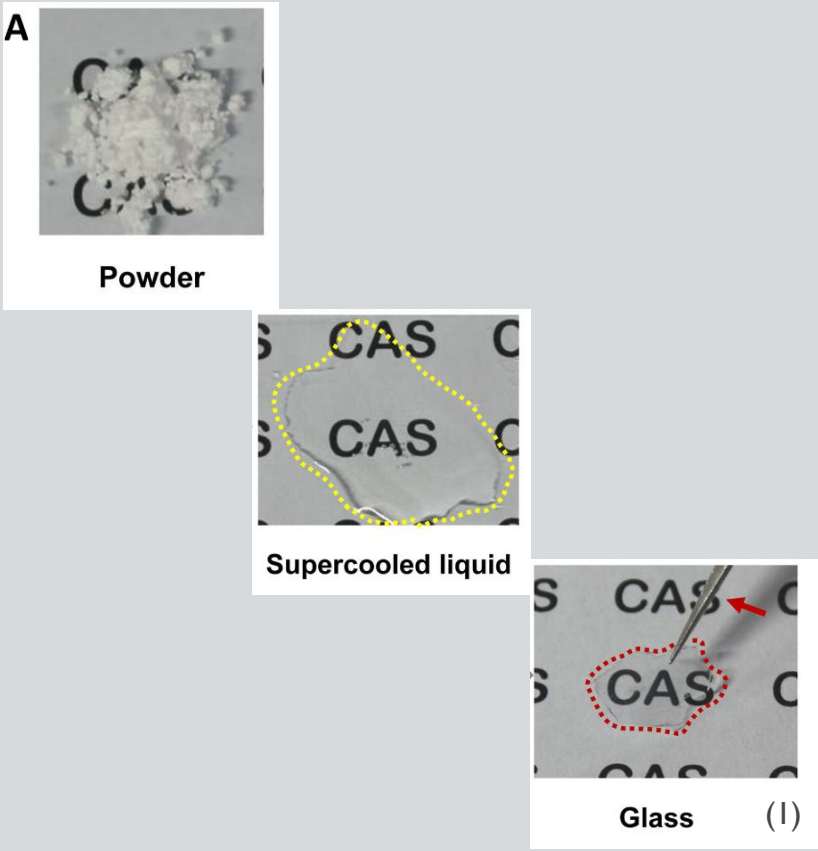

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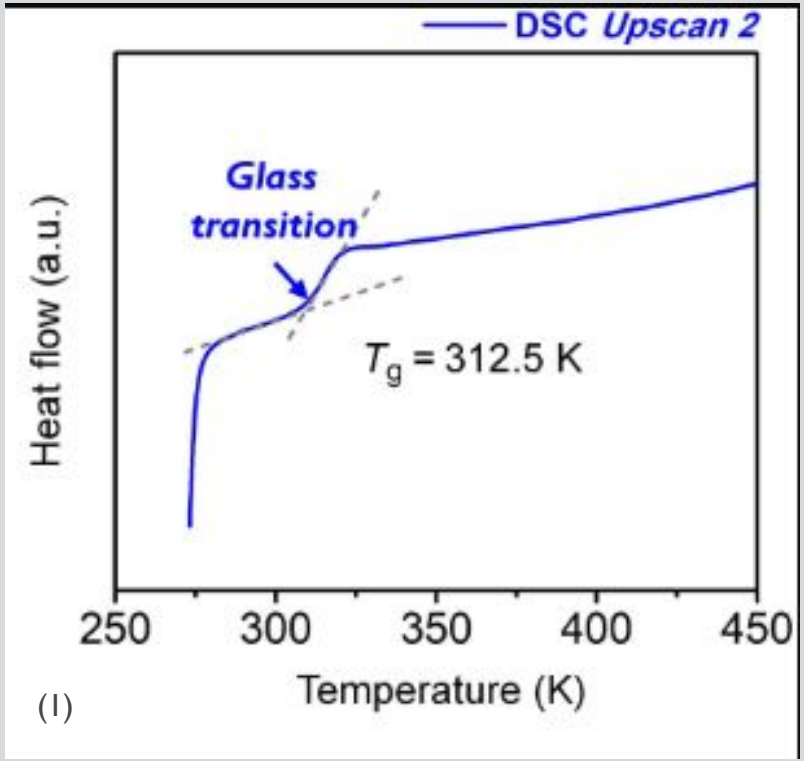
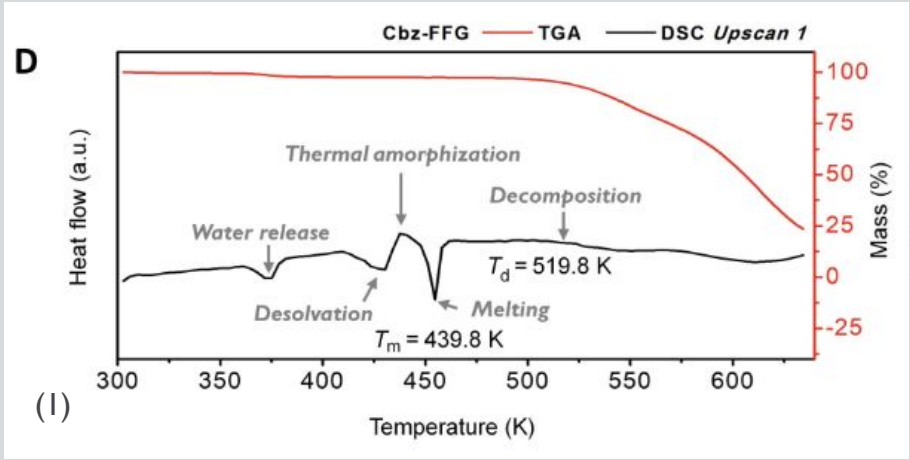
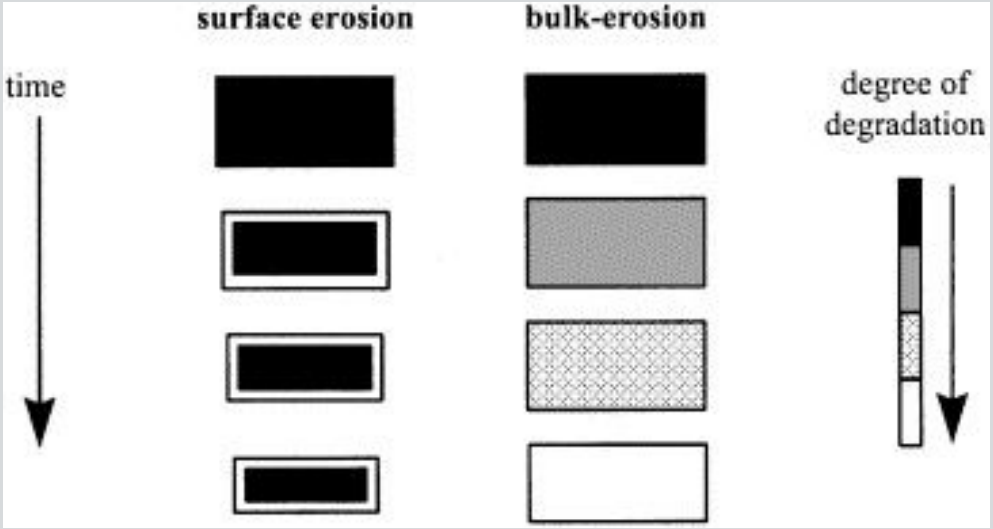
Glass Transition

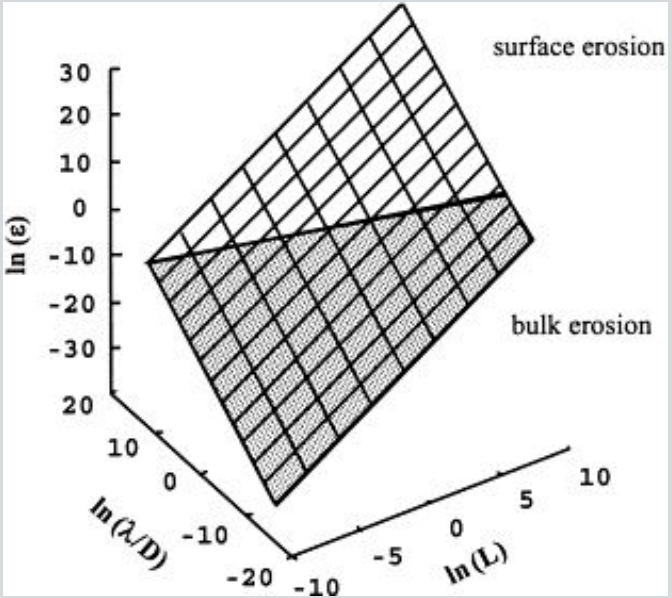


Tri-M melting temperature reported in the 473-573 K range (14)



Models for Hydrophobic Material Degradation

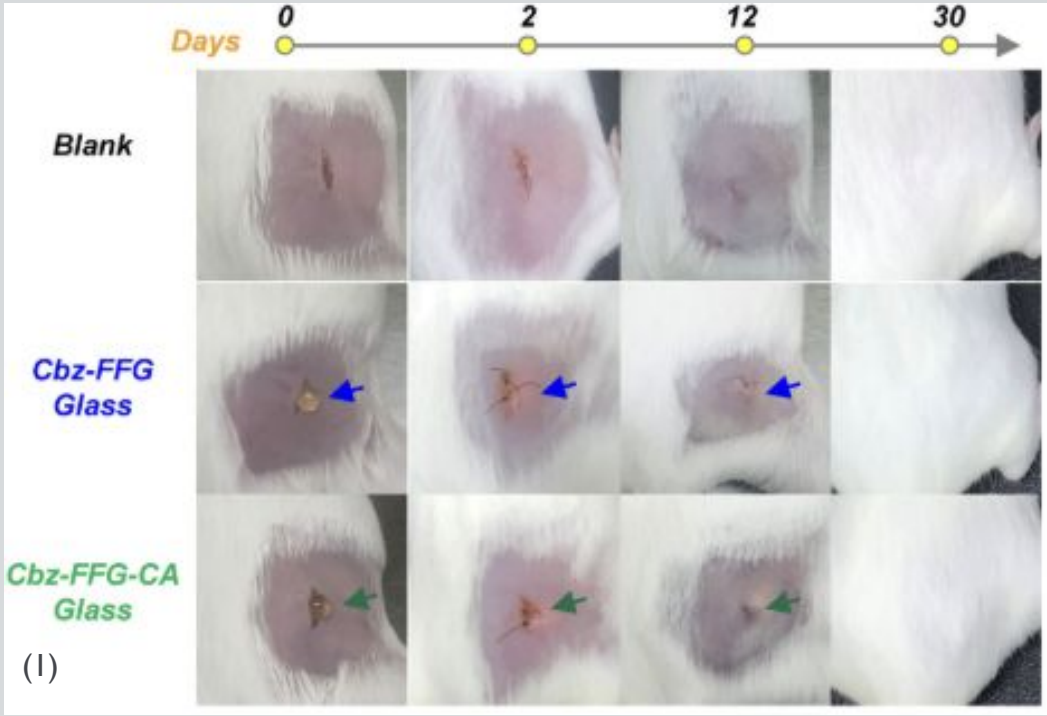


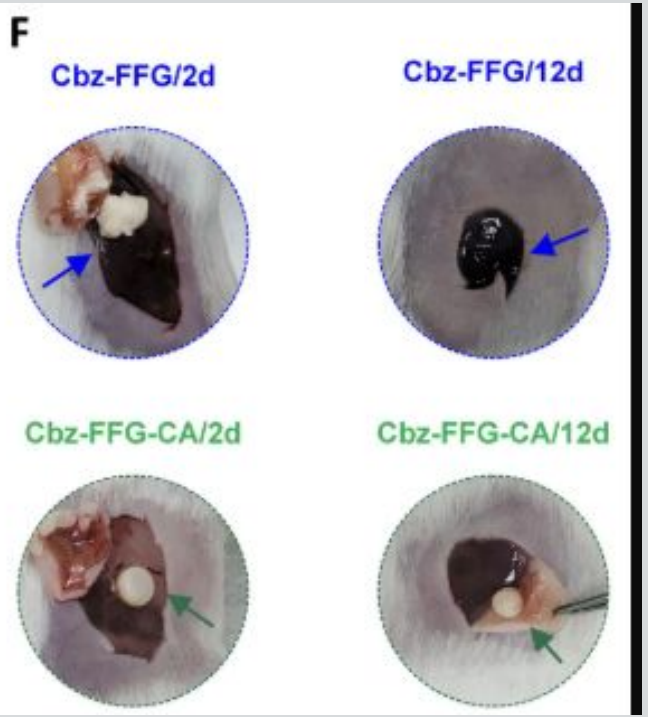


Bioglass beads can be represented by hydrophobic polymer degradation models

(17)

In Vivo Bead Degradation



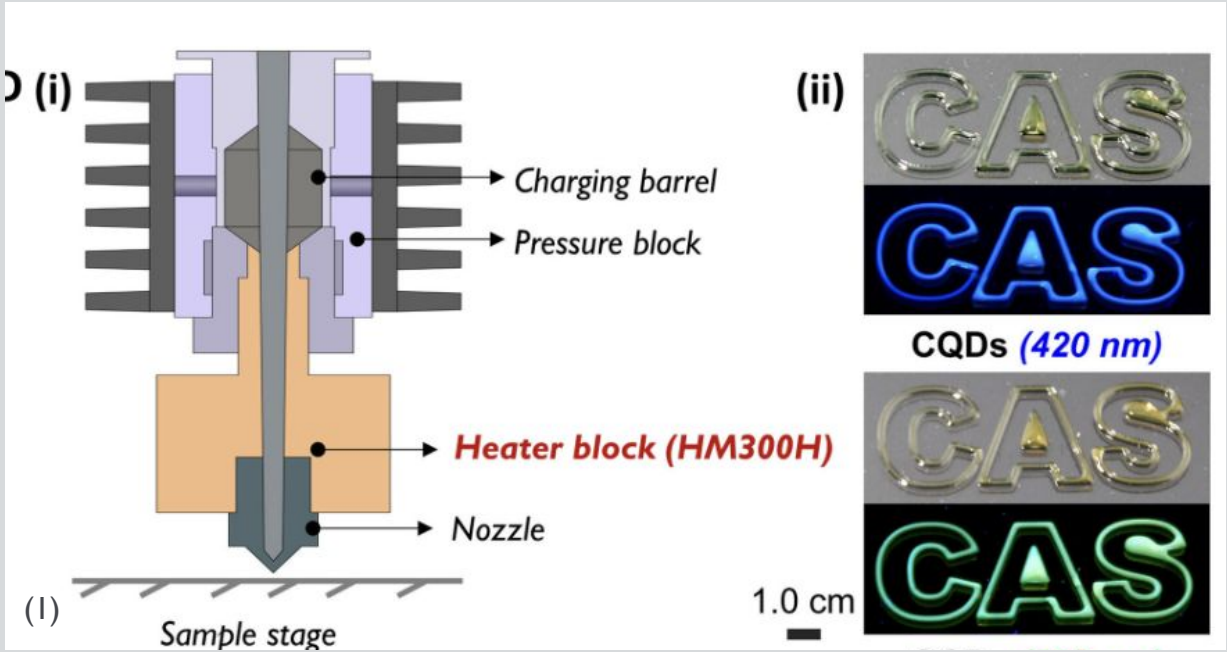


Decomposition Time vs Volume

- The size of biomolecular glass beads can be controlled via the length of the quenching process
- The volume of the bead is correlated with the time to degrade in vivo
- If dispersed through the volume, drug dosage should be controllable via tailoring degradation time

Bulk fabrication

- 3D printing via commercial bioprinters is viable; Tailoring bead size via nozzle size is also a viable option

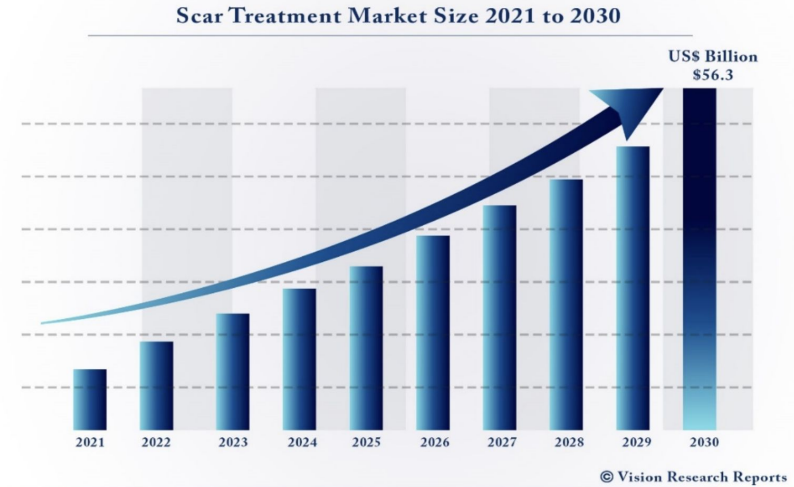


Summary

- Non-inflammatory and bio-safe drug delivery
- High in-vivo biocompatibility with no symptoms of pain, weight loss, edema, exudation or signs or immune rejection in the body
- Incorporation and extended release of small molecule drugs
- Long-term stabilization of bioactive molecules, does not require multiple visits
- Significant versatility to couple with a wide range of drugs

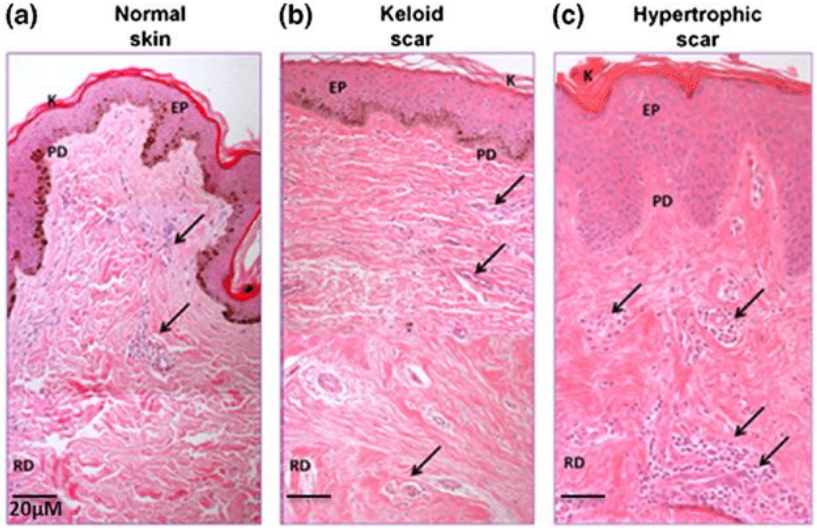
Implications and Future Work

- Minimally invasive method for scar treatment and prevention
- Slow-release functionality timeline has potential to be tailored based on microsphere volume
- Compatibility with additive manufacturing (bulk and 3D printing)
- Eco-friendly and can be an alternative to glass and plastic



Next Steps

- Test anti-fibrotic drug loading to test net compatibility and sustained release
- Optimize mechanical properties to match human dermis
- Evaluate safety and degradation in mammalian dermal environments
- Explore combinatorial drug possibilities
  (antibiotics, anti-inflammatory, ECM modulators)



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Thank you for listening!

Any Questions?

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