A Novel Bio-based Mesh for Treating Stress Urinary Incontinence

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Building Interdisciplinary Research Careers in Women's Health

BACKGROUND

- Polypropylene (PP) midurethral slings (Figure 1) are a common treatment for stress urinary incontinence, however they have a 3-5% complication rate including exposure of the mesh into the vagina (Figure 2) and excessive and deleterious foreign body response (Figure 3) due to a stiffness that is 30x that of the vagina.
- In addition to these compilations, PP mesh is a fossil-fuel based plastic. Carbon emissions from fossil fuels are raising the global temperature causing increasing frequency and severity of extreme weather events resulting in billions of dollars in damage
- Development of biobased plastics has the potential to reduce carbon emissions from plastic production by 1.3- 2.4 gigatons over the next 25 years with a net neutral long-term cost
- Polyurethane)PU) has a unique chemical structure which can be tuned to the mechanical properties of the vagina and can serve as a basis for a biobased mesh
- **Therefore, we sought to design a mesh for the vagina with improved patient outcomes and less environmental impact**

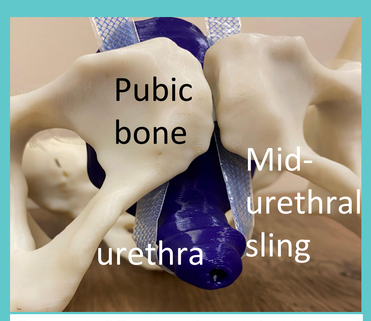


Figure 1. 3D printed model of the bony pelvis, bladder and urethra showing the approximate position of a midurethral sling.

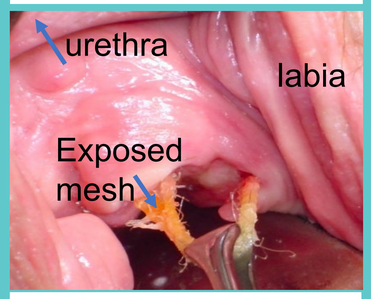


Figure 2. A vaginal mesh exposure of midurethral sling.

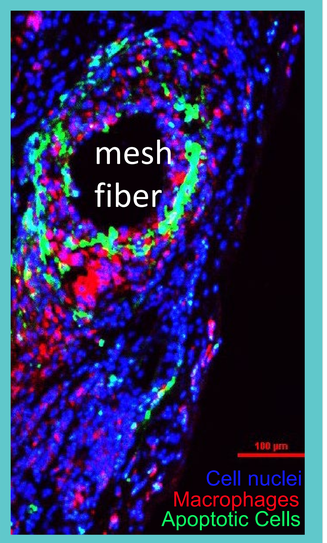
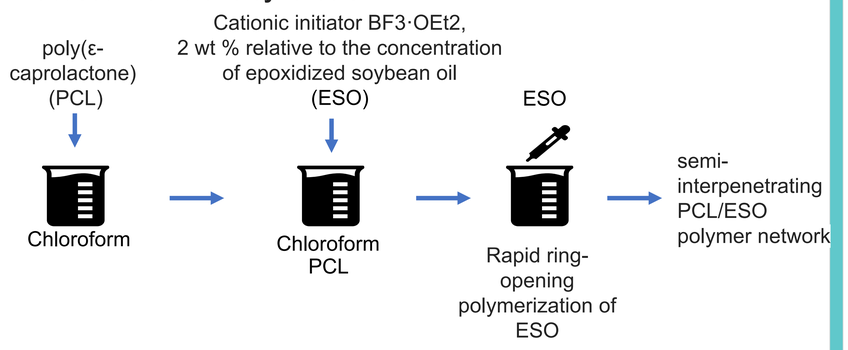


Figure 3. A proinflammatory response surrounding a mesh fiber of a vaginal PP mesh. Macrophages are labeled with CD68 and apoptotic cells with a TUNEL assay.

METHODS

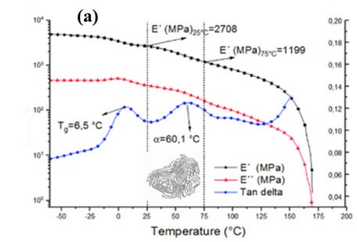
Biobased membrane synthesis



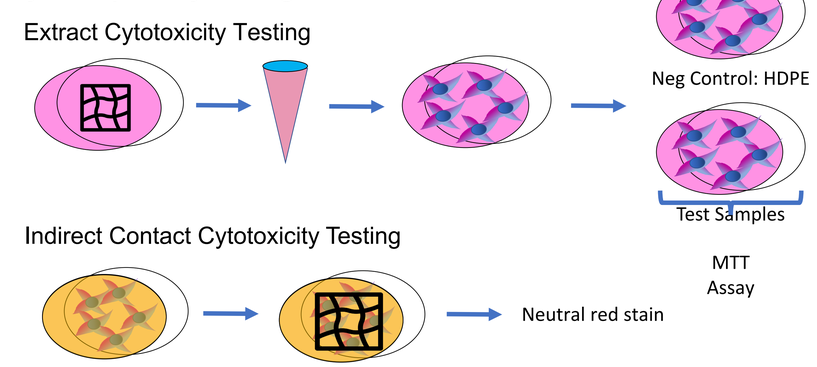
Compared with 3 medical grade thermoplastic polyurethanes (TPU)

- **Tecothane® Soft:** Medical Grade aromatic polyester TPU with up to 65% bio-based content
- **Tecoflex™ EG-85A:** Medical Grade aliphatic polyether-based TPU. .
- **Carbothane® PC-3572D:** Medical Grade aliphatic polycarbonate-based TPU.

Dynamic Mechanical thermal analysis

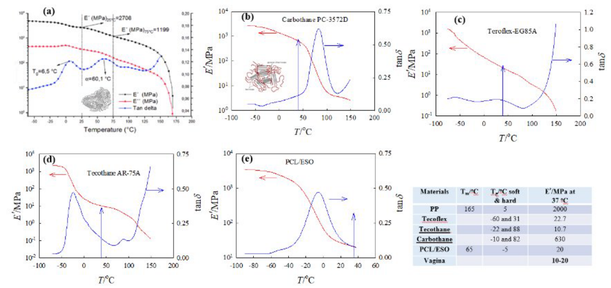


Cytocompatibilty Testing



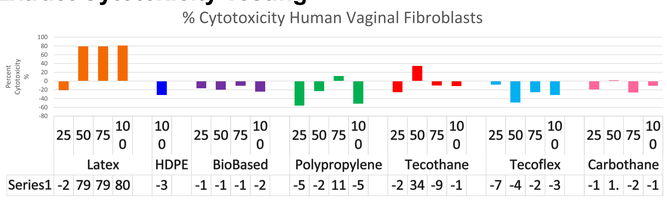
RESULTS

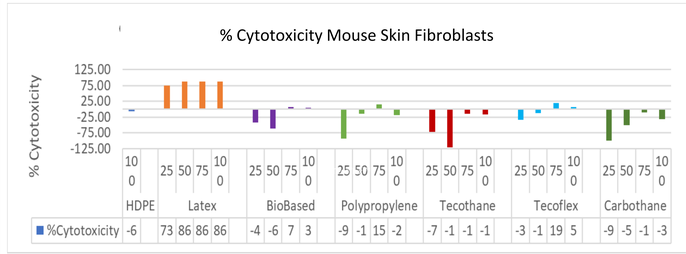
Dynamic Mechanical thermal analysis



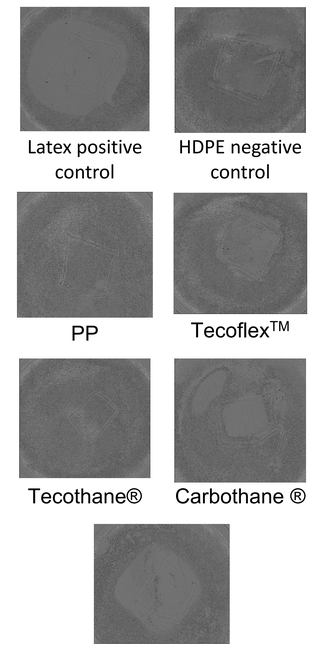
Materials	T_m/°C	T_g/°C soft & hard	E'/MPa at 37 °C
PP	165	-5	2000
Tecoflex		-60 and 31	22.7
Tecothane		-22 and 88	10.7
Carbothane		-10 and 82	630
PCL/ESO	65	-5	20
Vagina			10-20

Extract Cytotoxicity Testing





Indirect Contact Cytotoxicity Testing



CONCLUSIONS

- Tecoflex™, Tecothane® Soft, and bio-based blend PCL/ESO have similar mechanical properties and stiffness to that of the human vagina.
- Although Carbothane® was stiffer, this may be advantageous if polymer stiffness decreases dramatically in direct contact with human tissue and body fluid at 37°C.
- **The manufacturing process of the PCL/ESO blend may affect the cytotoxicity and needs to be further explored.**
- **Development of biobased materials are an important part of carbon reduction efforts**

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