Fig. S1. **Design and fabrication of sample holder for digital opto-electronic holography (DPOE) and laser Doppler vibrometry (LDV)**. (A) Customized 3D-printed holder was designed for use in DOEH and LDV experiments. The holder included a well for secure placement of a single TM composite graft or temporalis fascia. The cap was designed to completely cover the border region such that only the scaffold and collagen/fibrin infill were subject to acoustic testing. Dimensions for the base: inner hole diameter of 9 mm, well diameter of 25.5 mm, outer diameter of 35, inner well depth of 3 mm, and total length of 30 mm. The cap had the same inner and outer radii as the base with an extruded portion diameter of 25 mm, extruded portion length of 2.5 mm, and total length of 5.5 mm. (B) The holder was fabricated on an Objet Connex 500 printer (Stratasys, Minnesota, USA) with VeroBlue RGD840 rigid opaque material (Stratasys, Minnesota, USA). The design included four vertical pegs with a diameter of 2.6 mm to secure through gaps in the border region to restrict X and Y motion. It also included side pegs to secure the cap onto the base with elastics to restrict Z motion outside of the inner hole. (C) Placement of PDMS composite TM inside 3D-printed holder.

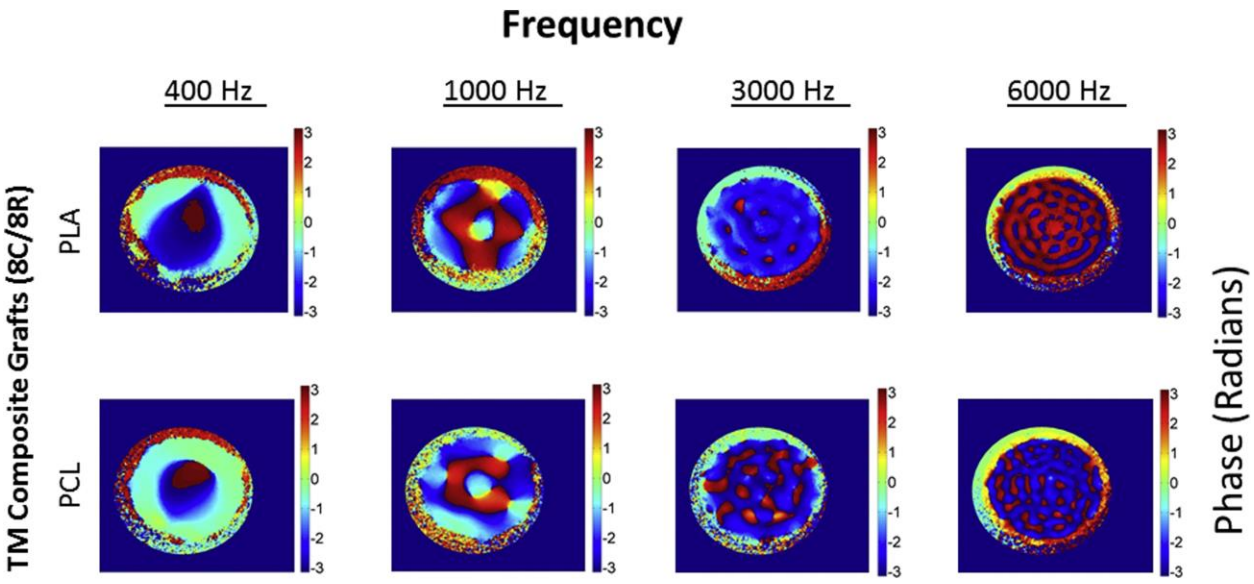

Fig. S2. Digital opto-electronic holography measured phase angle of tympanic membrane composite grafts fabricated with PLA and PCL. Representative digital opto-electronic holography (DOEH) images comparing the phase angle of the displacement relative to sound pressure in radians for PLA and PCL-based TM composite grafts. At 400 Hz, both grafts shows several adjacent areas of opposite phase: red and dark blue (phase of ± π radians) next to light blue (phase of ~0 radians). At 3000 and 6000 Hz, the phase patterns in these grafts show small cyclic variations in phase over the TM surface. Similar patterns are observed in human and animal TMs (Khanna and Tonndorf, 1972, Rosowski et al., 2011, Tonndorf and Khanna, 1970).