SUPPLEMENTAL INFORMATION

Heterogeneous Toroidal Spiral Particles for Islet Encapsulation

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TSP polymer solution

For PEG mixtures with larger MW (i.e. 700-8k and 700-20k), the minimum yet larger amount of photo-initiator was needed to form optimal TSPs. The bulk solution is made of glycerol and ethanol.

The viscosity and density of the polymer and bulk solutions were designed to manipulate the fine structures of the particles. The viscosities of the polymer drop, and the bulk solution were measured using a rheometer (Physica MCR 302, Anton Paar, Graz, Austria).

Table S1. TSPs polymer solutions composition

Name of the polymer solution	PEGDA 700 (wt%)	PEGDA 8000 (wt%)	PEGDA 20000 (wt%)	Glycerol (wt%)	water (wt%)	I-2959* (wt%)
700-82%	82	-	-	0	10	0.03
700-50%	50	-	-	24	18	0.03
700-40%	40	-	-	28	24	0.03
700-8k-40%	24	16	-	34	18	0.10
700-20k-32%	23	-	9.7	32	31	0.44

*photoinitiator I-2959 is dissolved in ethanol

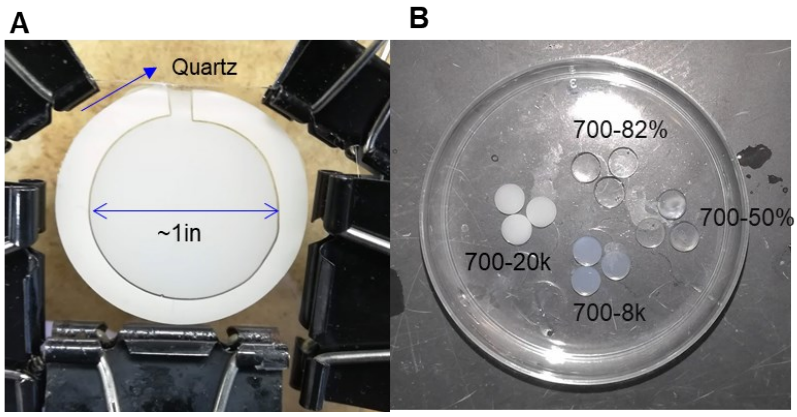

Figure S1. Polymer **f**ilm fabrication. **A.** UV-crosslinked PEGDA 700-20k film in between two quartz using a Teflon mold. **B.** Discs made of various PEGDA compositions.

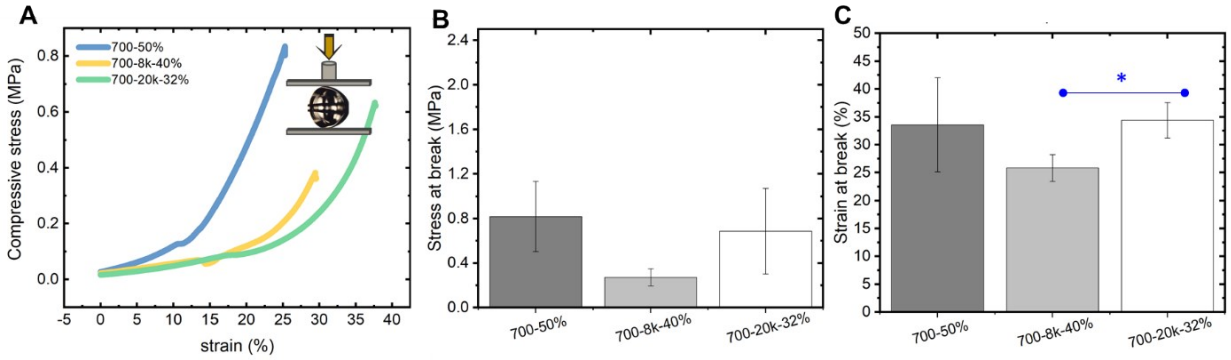

Figure S2. Stress-strain measurements of TSPs when compressive stress was applied to the side. **A**. Representative stress-strain curve of TSPs of various PEG compositions and concentrations. **B.** TSPs maximum stress at failure. **C.** Maximum strain at failure. Error bar was calculated as the standard deviation of n≥4 measurements per sample and the statistical significance is indicated as *p<0.05.

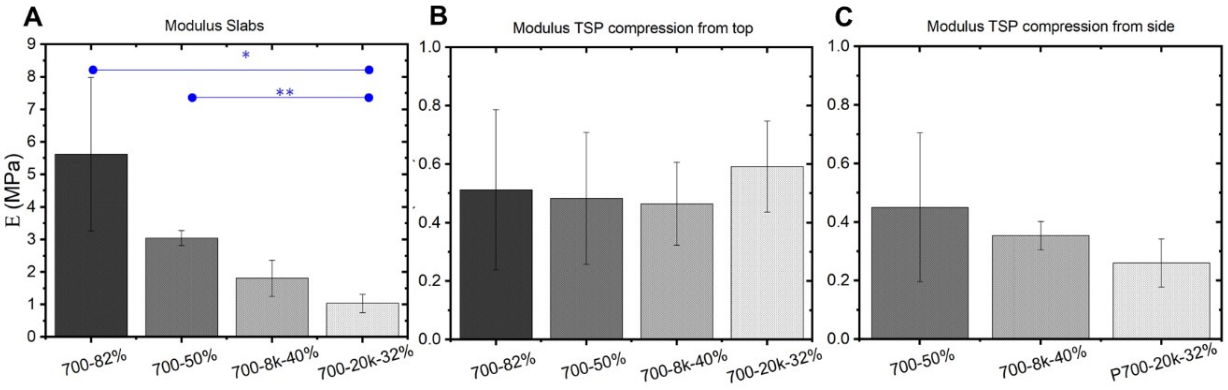

Figure S3. Compressive modulus of hydrogels of **(A)** discs and **(B)** TSPs when stress was applied to the top and **(C)** TSPs when stress was applied to the side. Error bars correspond to the standard deviation of n≥4 samples, and significance * p<0.05, **p<0.05.

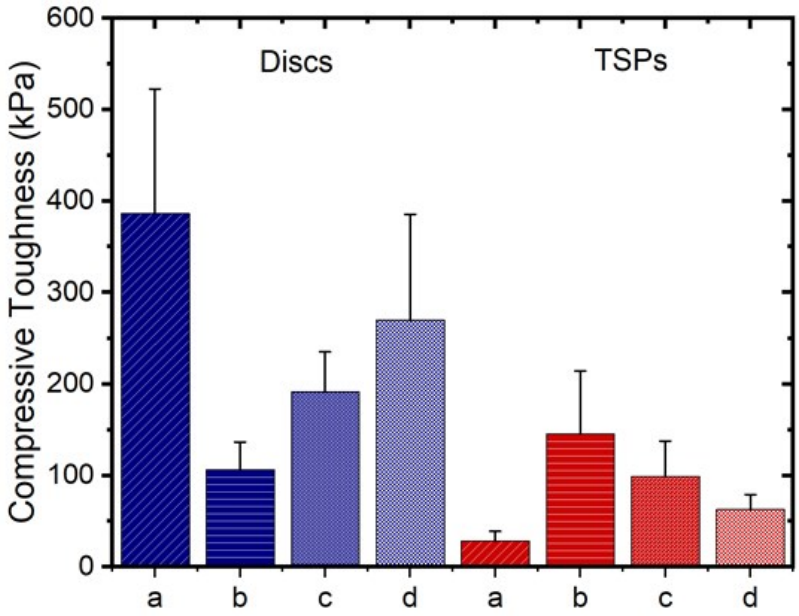

Figure S4. Toughness of the hydrogels of discs or TSPs. The x-axis labels correspond to the polymer composition as: a. 700-82%, b. 700-50%, c 700-8k-40% and d. 700-20k-32%. Error bars correspond to the standard deviation of n≥4 samples.

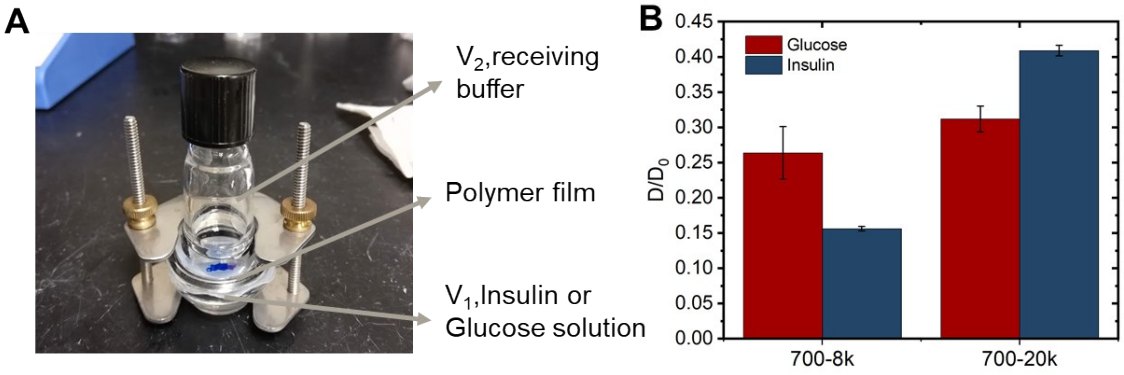

Figure S5. **A.** Custom-made diffusion cell used for studies of glucose and insulin diffusion through the polymer films. The PEGDA film (300 μm) was placed in between the two chambers. **B.** Normalized diffusion coefficients, respect to the aqueous diffusion coefficient (D_0), of insulin (blue) and glucose (red) respectively through PEGDA films of different PEG compositions. Error bars represent the standard deviation of n=3 samples.

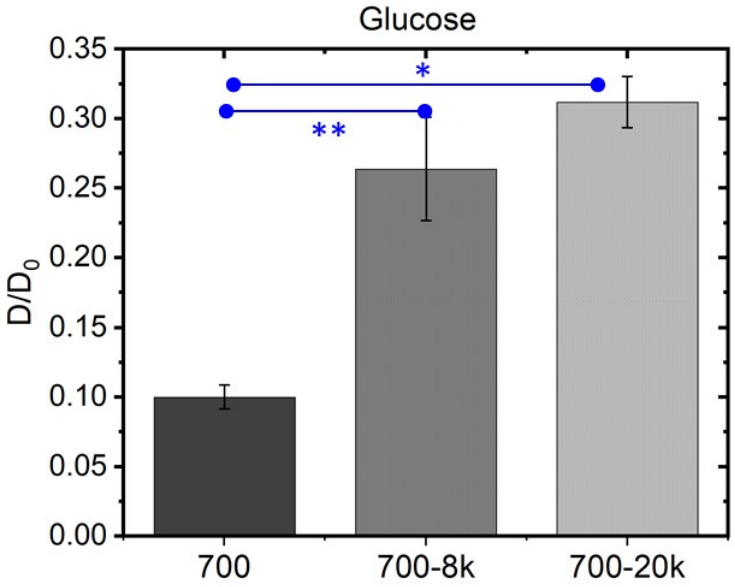

Figure S6. Measurements of glucose diffusion coefficient through PEGDA-films made of P700, P700-8k and P700-20k**.** The calculated glucose diffusion coefficient was normalized with its aqueous diffusion coefficient (D_0). Error bars correspond to the standard deviation among different samples, n=3, and significance as * and **p<0.05.

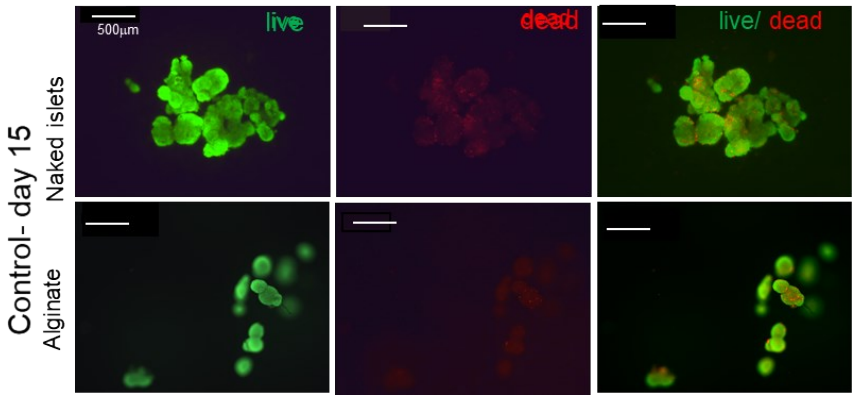

Figure S7. Viability of naked human islets and mixed with alginate, monitored up to 15 days as controls. The scale bars represent 500 µm.

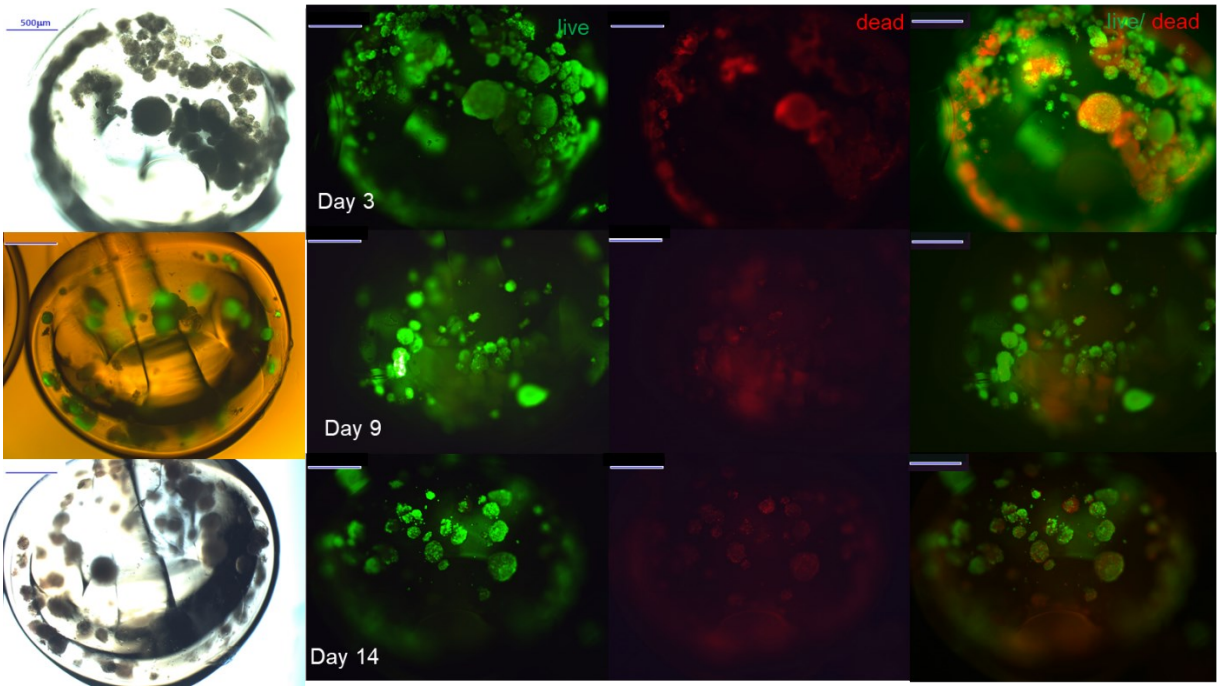

Figure S8. Viability of non-human primate (NHP) islets loaded in TSPs with extra high cell number densities (~160 IEQ per TSP) up to 14 days. The scale bars represent 500 μm.

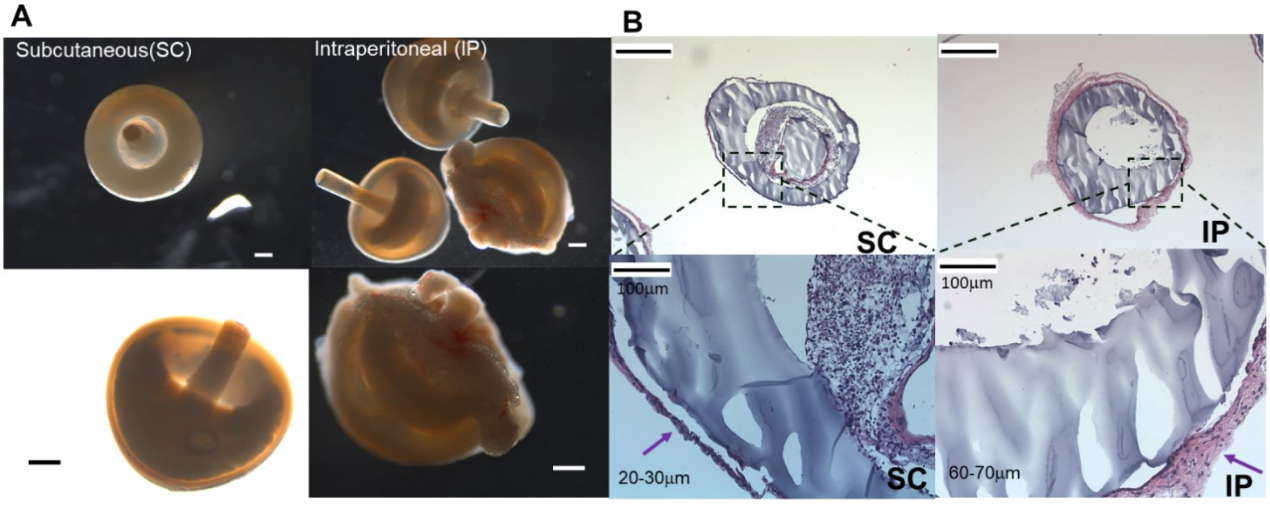

Figure S9. Retrieved TSPs made of PEG 700-20k from nude mouse after 4 weeks implanted subcutaneously or intraperitoneally. **A**. Bright field images. The scale bars represent 500μm. **B**. H&E images. The scale bars represent 500μm for the top row and 100μm for the bottom row.

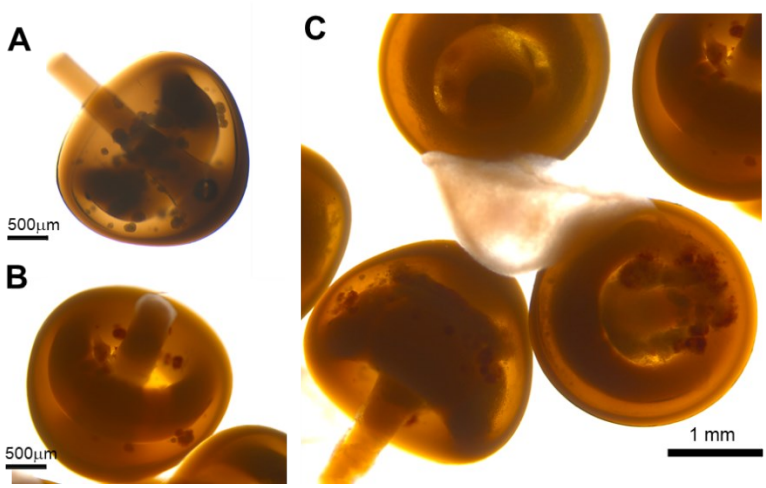

Figure S10. Human Islets encapsulated in TSPs made of PEG 700-20k. **A**. Before transplantation. **B** and **C.** Dithizone-stained TSPs retrieved after 28 days in IP cavity of STZ-diabetic nude mice.