Supporting Information

Upcycling Sargassum Biomass into Biodegradable Mulch Films via Sodium Alginate and Recycled Polyvinyl Alcohol

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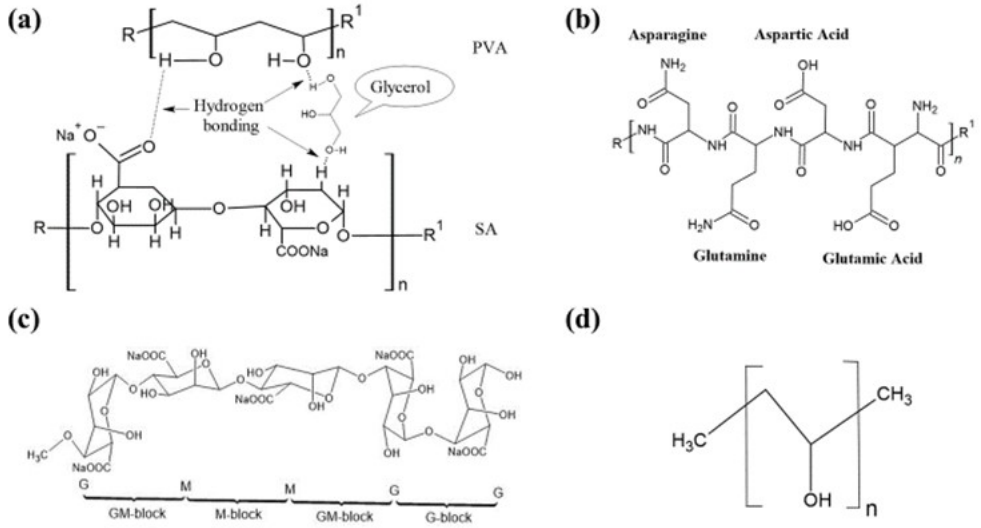

Figure S1. A schematic overview diagram of the research, including chemical structures of the main components used in this study. (a) Hydrogen between PVA, Sodium Alginate, and glycerol. (b) Representative polypeptide structure of Zein showing common amino acid residues such as glutamine, leucine, proline, and serine. (c) Structural representation of sodium alginate biopolymer highlighting guluronic acid (G) and mannuronic acid (M) blocks. (d) Repeating unit of poly (vinyl alcohol).

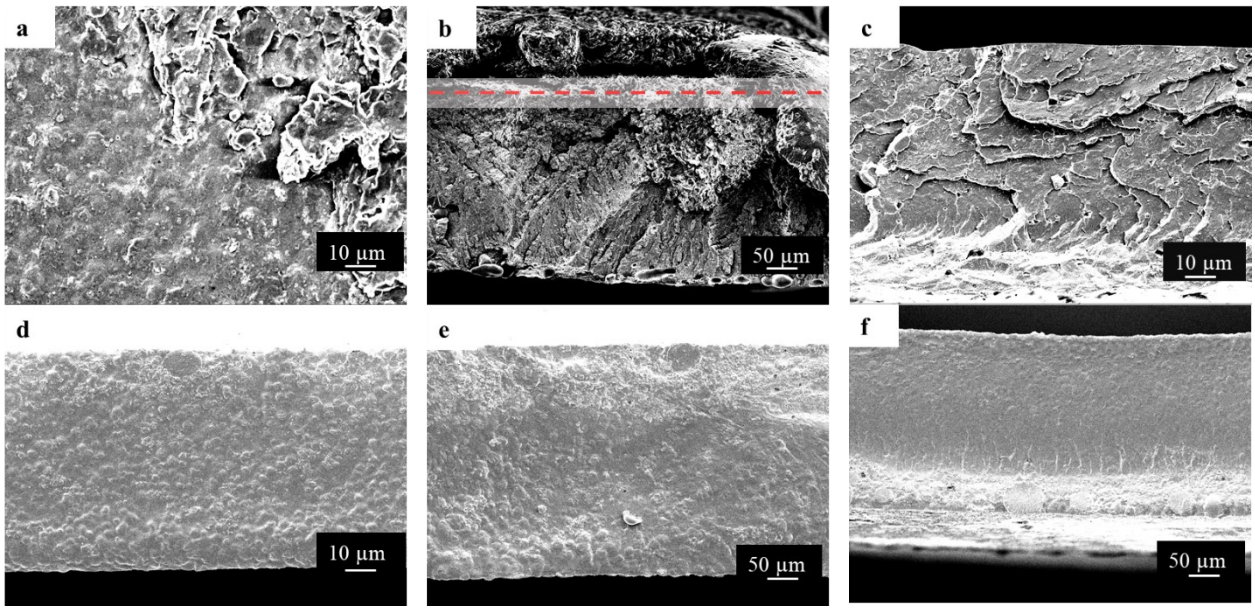

Figure S2. SEM images of biodegradable films: (a) surface, (b) cross-section of beeswax-coated film, (c) polyethylene control, (d-f) sodium alginate/PVA films with increasing glycerol concentrations.

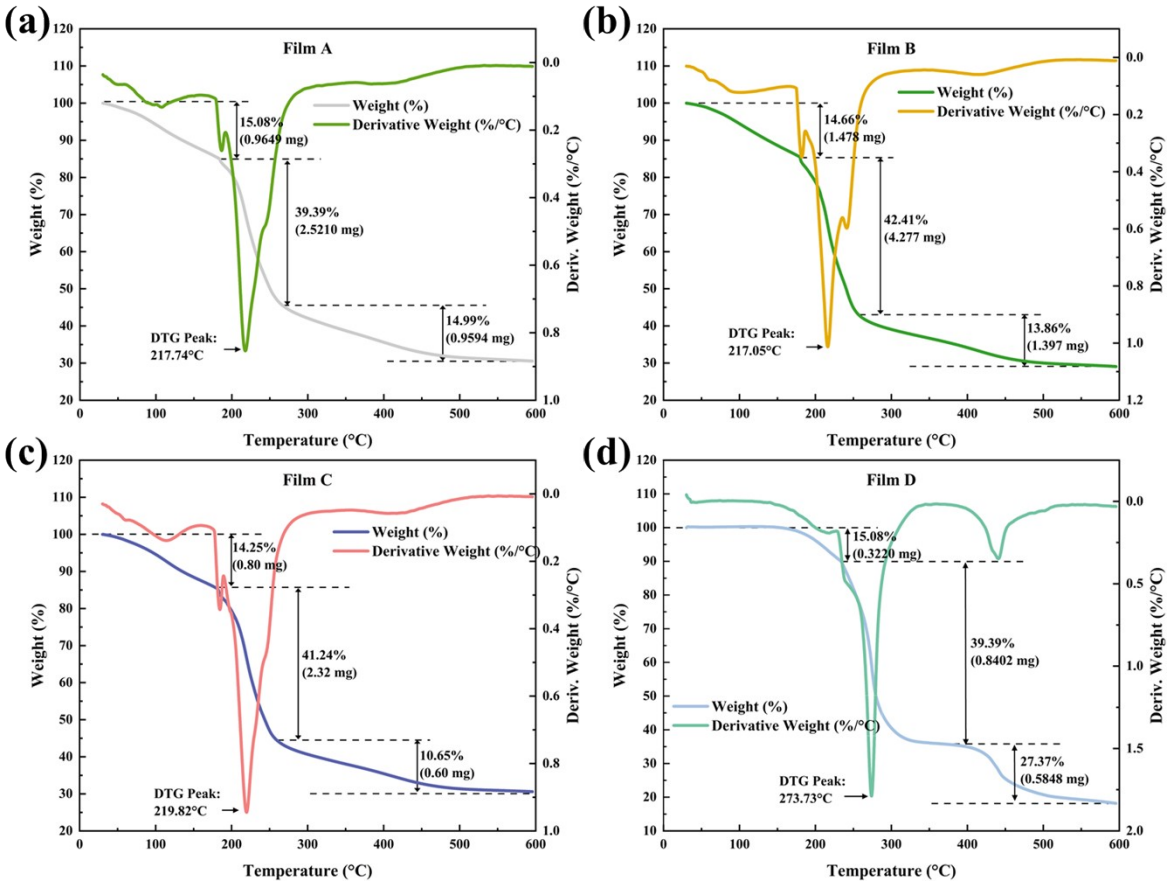

Figure S3. TGA and DTG curves of (a-c) biodegradable and (d) conventional mulch films.

Figure S4. Soil toxicity test setup following OECD 207 with earthworms; 7-day survival rate recorded.

Table S1. Water absorption (%) of films under different humidity conditions after 1 and 2 Weeks.

Film	Humidity (% RH)	Week 1 Water Absorption (%)	Week 2 Water Absorption (%)
A1	30 ±5	-19	-19
A2	50 ±30	-9.5	-9.3
A3	75 ±5	-5.1	-3.7
C1	30 ±5	-12.2	-12.3
C2	50 ±30	-2.8	-2.5
C3	75 ±5	1.3	1.5

Table S2. Earthworm survival rates (%) in control and test soils after 7 days.

Group	Replicate	Initial Count	Survivors (Day 7)	Survival Rate (%)
Control Soil	1	10	10	100%
Control Soil	2	10	10	100%
Control Soil	3	10	10	100%
Average	—	—	—	100%
Test Soil A	1	10	10	100%
Test Soil A	2	10	10	100%
Test Soil A	3	10	10	100%
Average	—	—	—	100%