Supplementary Information (SI) for RSC Sustainability.

Supporting Information

of

Utilizing Waste Solvent from Distilled Spirits Production to Upcycle Backsheets of Solar Panels

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Table S1: Module information

Specifications	Multicrystalline silicon module
Manufacturer	ACOPOWER
Module Number	HY100-12P
Total Weight (kg)	9.5
Dimensions	40.2” L × 26.4” W × 1.4” H
Voltage (V)	12
Power (W)	100

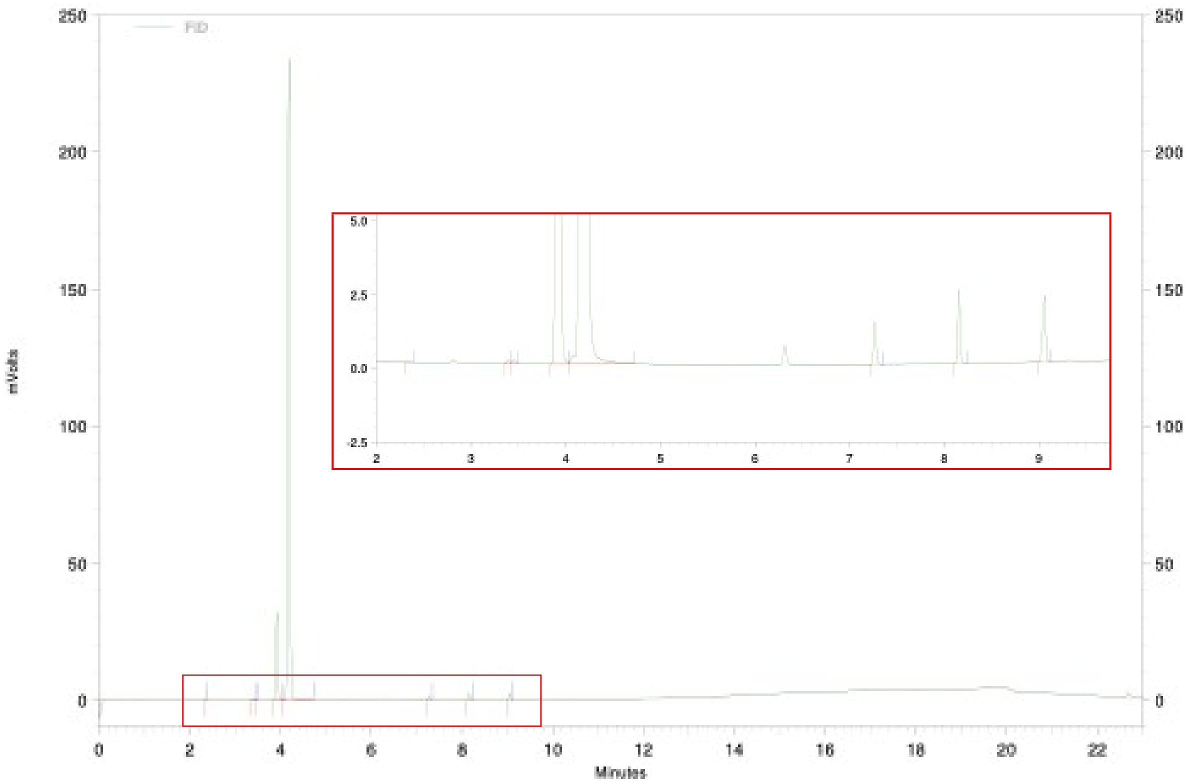
Distilled Spirits Production

A total of ten different grains, consisting of 5 corn and 5 rye varietals, were used for distilled spirit production. Each grain variety was weighed (10 lbs) and milled into flour using an electric flour mill (Grain Mill 150). In a 15.5-gal stainless steel vessel, a total of 5 gal of brewing water was prepared using a 1:1 ratio of tap water and deionized water with a calcium sulfate addition (10 g) for a balanced ion profile. After heating the water to 50°C, the grain flour was added and mixed thoroughly. For each mixture (mash), the pH of the solution was measured and adjusted to pH 5.5 using phosphoric acid (10%) as needed. The mash was then heated to 85°C, followed by a 2.3 g of a-amylase (Amylex 6T, Gusmer Enterprises) addition. After 30 minutes, the mash temperature was reduced to 65°C, followed by a 3.2 g glucoamylase (Diazyme SSF2, Gusmer Enterprises), 12 g yeast nutrient addition, and a 30-minute temperature hold. A yeast solution was prepared in a separate, sanitized beaker to rehydrate 8.2 g of Saccharomyces Cerevisiae yeast (VIC-23, Renaissance Yeast) in 100 mL of deionized water preheated at 40°C. The mash temperature was reduced to 30°C and transferred to a sanitized 6.5-gal fermenter along with the yeast solution. Once sealed with a one-way airlock, the solution was allowed to ferment at room temperature for 8 days.

Once the fermentation process was complete, two subsequent distillations were performed (stripping and finishing run). The contents of the fermenter were transferred into a 13-gal pot still (Affordable Distillery Equipment LLC) and diluted with 1.5 gal of deionized water due to thickness. A simple distillation, without using a column for rectification, was used for the first distillation (stripping run), collecting the distillate until the measured alcohol by volume (ABV) was below 5%. This collected distillate (low-wines) was subjected to a second distillation (finishing run) in the same pot, which is still now utilizing a copper column for increased rectification to separate fractions. Flow rates for cooling water were held constant to maintain a consistent reflux. During this second distillation, the distillate was collected as separate fractions (heads, hearts, and tails) determined by sensory and distillate ABV off the still. Once each grain varietal had been fermented and distilled, equal volumes of each head distillate were mixed and used as a collective solvent later (i.e., waste ethanol) in this work.

Stoichiometric Basis for PET Alkaline Hydrolysis

The repeat unit for PET has a molar mass of 164 g/mol, and two moles of base are required for each repeat unit. 1.00 g of PET corresponds to approximately 6.1 mmol of repeat units in the system. Since two moles of base are required to react to completion, 12.2 mmol of base are required in a strict 1:1 ratio. Excess is used to ensure a complete reaction is achieved and to account for impurities within the PET system, mass diffusion limitations, and water which may be present in the base due to the atmosphere. This procedure is similar to other reactions used for PET alkaline depolymerization.



FID Results

Name	Retention Time	Area	Height	ISTD concentration (ppm)
Acetaldehyde	2.332	87	38	80.712
Ethyl Acetate	3.388	277	115	419.701
Methanol	3.448	297	124	368.166
1,2-Dimethoxyethane	3.913	83387	31830	86700.000
Ethanol	4.186	749358	233424	667966.129
Isobutanol	7.268	2880	1437	1676.302
Butanol	8.153	4360	2486	2548.228
Isoamyl Alcohol	9.059	4881	2242	2693.034
Totals		845527	271696	762452.272

Figure S1. GC of the waste ethanol 'heads' stream (~80% v/v ethanol) showing only ppm-level co-volatiles with 1,2-dimethoxyethane as internal standard (ISTD); no correction of solvent volume was applied in depolymerization experiments.

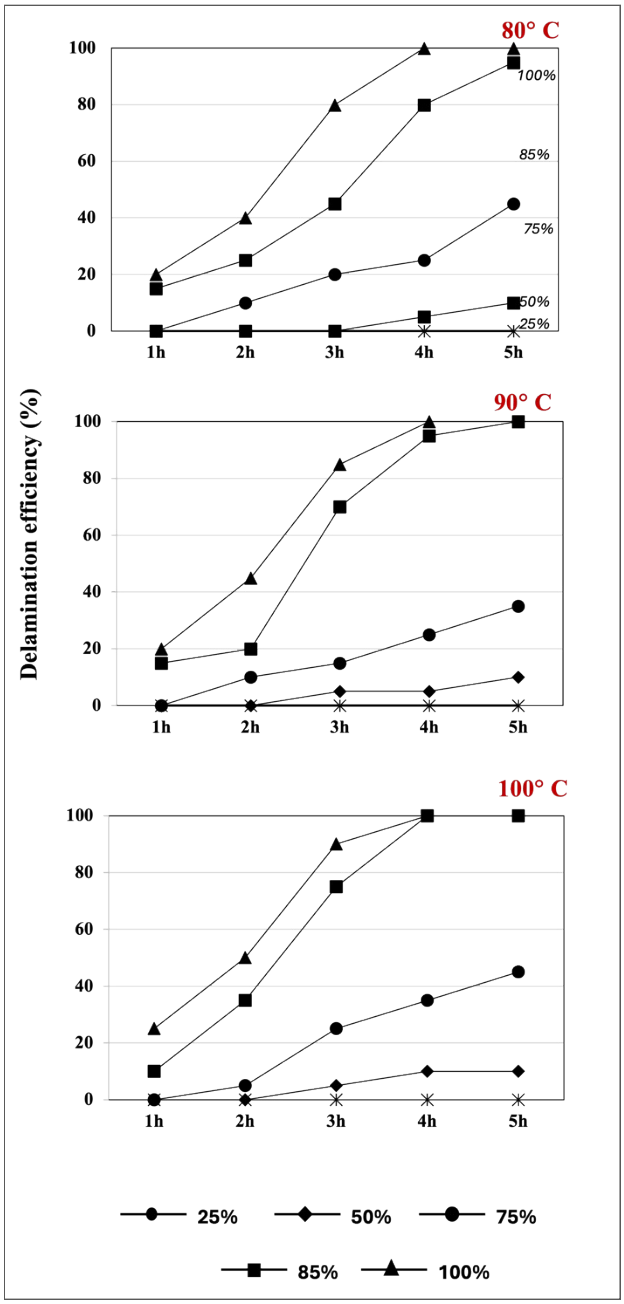


Figure S2. PV backsheet delamination efficiency for reflux temperatures

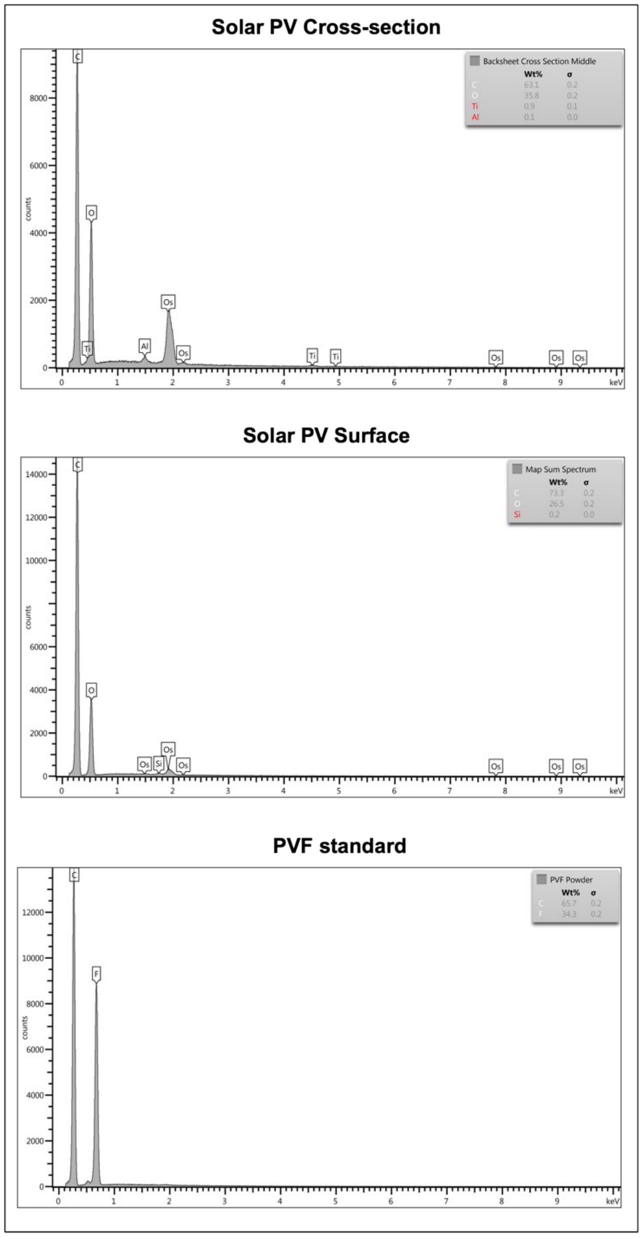


Figure S3. EDX of Mono-crystalline silicon module showing the presence of fluorine