

Candidate Inexpensive Solar Cooker Component Materials

Goal – to identify potential materials for inexpensive solar cookers (materials costs <\$10/m², cookers with an area of ~1 m²), updating the materials analysis performed by FSEC in 2001 (found at http://www.fsec.ucf.edu/en/research/solarthermal/solar_cooker/documents/reflectivematerialsreport.pdf)

These materials could be used to build a variety of different kinds of solar cookers, but of particular interest is the “panel” type as exemplified by the CookKit, presently manufactured using household aluminum foil glued onto cardboard and considered not sufficiently durable. A lifetime of several years in bright sunlight is desired.

Product	Website	Low Volume (\$/m ²)	High Volume (\$/m ²)	Description
Aluminum foil	http://www.foodservicedirect.com/index.cfm/S/33/N/86841/15X1000-Standard-Aluminum-Foil-Roll.htm	\$41 for 12’’x1000’ 94 m ² @ \$.43/m ²		
Aluminum foil (heavy duty)	http://www.reliablepaper.com/18_X_500_Extra_Heavy_Aluminum_Foil_Roll_p/WPL286AC.htm	\$35 for 18’’x500’ 70 m ² @ \$.50/m ²		
Indoor Gardening Materials				
.002’’ mylar	http://www.mylarstoreonline.com/150ft.html	\$30 55’’x25’ 10.7 m ² @ \$2.80/m ²	\$80 55’’x150’ 64 m ² \$1.25/m ²	Generally polyethylene terephthalate (boPET)
.003’’ mylar	http://www.mylarstoreonline.com/150ft.html	\$50 55’’x25’ 10.7 m ² @ \$4.70/m ²	\$120 55’’x150’ 64 m ² \$1.86/m ²	

Foylon	http://www.bghydro.com/BGH/static/media/Light%20Meters,%20etc%2021.pdf	\$70 48"x25' 9.4 m ² @ \$7.45/m ²	\$270 48"x100' 37.4 m ² \$7.25/m ²	Industrial strength
Ecoplus Sunfilm	http://www.orchidgreenhouse.com/ecoplussunfilmultra48inx50ft.aspx	\$56 48"x50' 18.7 m ² @ \$3/m ²		Thick, woven mylar
Permafect	http://www.hydrofarm.com/pb_detail.php?itemid=7689	\$38 25"x54" 10.5 m ² @ \$3.60/m ²	\$125 54"x100' 42 m ² \$3/m ²	Matte finish
Building Radiant Barrier Materials				
Radiant GUARD Ultima	http://www.radiantguard.com/ultima-radiant-barrier-1000sf.aspx	\$140 48"x250' 93.6 m ² @ \$1.50/m ²		Scrim between 2 aluminum layers – <i>premium grade</i> , of 3
Astro-White I	http://www.shop.com/ASTRO_WHITE_I_Reflective_Foil_Insulation-9136873-13870303-p+.xhtml?sourceid=298 http://www.insul.net/prod_astrofoil_all.html	\$126 48"x125' 46.8 m ² @ \$2.70/m ²		Astro-Foil building insulation, single bubble plus pure Al – representative of a whole family of reflective bubble insulations
Aluma-Foil	http://www.smartlivingdirect.com/alluma-foil-super-plus.html	\$70 500 ft ² 46.8 m ² @ \$1.50/m ²		Advanced Foil Systems makes a variety of products
ARMA-Foil	http://www.energyefficientsolutions.com/rbproducts.asp	\$45 24"x125' 23.4 m ² @ \$1.92/m ²	\$139 48"x250' 93.6 m ² \$1.50/m ²	Polyethylene with foil on each side – several varieties are available
Other Inexpensive Reflective Materials				
Mirror sign	http://www.solreka.com/chrome-mirror-	\$6		For example. Manufacturers

film, advertised for solar cookers	reflective-sign-vinyl-1-metre.html	.6m x 1m .6 m ² @ \$10/m ²		include Arlon, Avery, RTape/VinylEfx, and Oracl
Chrome mirror sign film	http://www.montroy.com/catalog/main/itemdetail.app?item_no=A1846S3050&desc=30%2050%20Yd%20Chrome%20Mirror%20Avery%20Specialty%20Film	\$392 30"x 50 yards 35 m ² @ \$11/m ²		Avery brand sign film – rated up to 5 years outdoors
Super Premium Reflective Materials – for Comparing Quality and Pricing				
SolaReflex AA	http://home.att.net/~cleardomesolar/solareflexpanels.html	\$18 2'x4' .75 m ² @ \$220/m ²		
Solarflex	http://home.att.net/~cleardomesolar/solarflex.html	\$75 4'x10' 3.7 m ² @ \$20/m ²	\$279 4'x125' 46.8 m ² \$6/m ²	7-10 years outdoor rating
Reflectech	http://home.att.net/~cleardomesolar/solareflexpanels.html	\$84 2'x5' .94 m ² @ \$89/m ²	\$830 5'x30' 14 m ² \$59/m ²	15-20 year outdoor rating
ReflecTech	http://www.reflectechsolar.com/pricing.html	\$32/m ²	\$19/m ²	professional solar grade material – the ultimate, with +10 year outdoor rating
Reflective Acrylic 1/8"	http://www.estreetplastics.com/Plexiglass_Acrylic_Mirror_Sheets_1_8_thick_s/38.htm	\$39 24"x48" .75 m ² @ \$52/m ²		"acrylic mirror"
Rigid Structural Materials				
Acrylic/Lexan 1/8"	http://www.professionalplastics.com/PLEXIGLASS-ACRYLIC SHEET-EXTRUDED	\$99 48"x96" 3 m ² @ \$33/m ²	\$77 48"x96" 3 m ²	

			\$26/m ²	
Acrylic/Lexan 1/4"	http://www.eplastics.com/Plastic/Plexiglass_Acrylic_Sheet_Clear	\$200 48"x96" 3 m ² @ \$67/m ²	133 48"x96" 3 m ² \$44/m ²	
ABS .040"	http://www.professionalplastics.com/ABSSHEETFORMINGGRADE	\$20 48"x96" 3 m ² @ \$6.67/m ²		acrylonitrile butadiene styrene
ABS 1/8"	http://www.professionalplastics.com/ABSSHEETFORMINGGRADE	\$58 48"x96" 3 m ² @ \$19/m ²		
ABS 1/4"	http://www.professionalplastics.com/ABSSHEETFORMINGGRADE	\$107 48"x96" 3 m ² @ \$36/m ²		
Coroplast Corrugated (4 mm)	http://corrugatedplastics.net/4mmCorrugatedPlasticSheets.html#48x96	\$16 48"x96" 3 m ² @ \$5/m ²	\$9 48"x96" 3 m ² \$3/m ²	"corrugated plastic" brand <u>example</u> , available in different thicknesses (but thinner is not always cheaper)
Other Resources				
MDI Plastics	http://www.mdiplastics.com/			sole manufacturer of corrugated plastic postal totes
Diversi-Plast	http://www.diversi-plast.com/diversiplast/DivPlast.nsf/8%20Plastic%20Styles?OpenPage			attractive vendor with good corrugated plastic manufacturing experience
Thomas Register Listing	http://www.thomasnet.com/products/plastic-sheet-sheeting-corrugated-60000551-1.html			master list of corrugated plastics manufacturers, by state

General Comments

1. The target cost limits choices for the 2 critical components, the reflective surface material and the durable structural backing (there exist cases where these two are one and the same – such as acrylic mirror and polished aluminum sheet – but no inexpensive ones have been found). Sources and prices in the table are for example only – while it is expected that these are representative, lower prices can generally be negotiated or found offshore; “low volume” indicates a sufficient amount for several cookers (or the minimum size available) while “high volume” gives some indication of the trend in pricing with quantity.
2. Reflective “films” (minimal material supported a thin substrate, available in large rolls and inexpensive to ship) are used in a variety of *high volume applications*, including food service, indoor gardening, building construction, sign making, etc. While these can be inexpensive ($< \$5/m^2$), often very little is known about their technical characteristics – such as their reflectivity and outdoor durability. By creating a table of choices, the goal is to identify first which materials can meet the cost target, then investigate further select ones which seem to have the best technical attributes – there is no substitute for building solar cookers and trying them in the field to see if the reflective characteristics are adequate and if they can hold up in the real world.
3. Replacements for the present cardboard backing material need to be more durable, and inexpensive plastics are expected to be the majority of the choices besides locally available wood. It may not be necessary for these to be rigid – there are designs for soft cookers and ones where the reflective material is supported by ribs, such as in an umbrella – and if not needed this cost can be saved, but panel and box cookers are the most familiar types and their durability/longevity might be expected to be better. In order to meet the cost target, the most inexpensive plastic types must be used, and their mass per unit area should be minimized – even thin sheets of “engineered plastics” (those designed for performance – and including such unnecessary features as strength and transparency) are often too expensive when priced by the square meter. ABS sheet .040” thick (1/25th of an inch) was the only solid plastic which seems to have the potential to meet the cost target, but other sufficiently thin plastic examples (e.g. acrylic, polycarbonate, polystyrene, polyethylene, polypropylene) may also exist with acceptable pricing.
4. A candidate plastic board type that is difficult to ignore goes by the general name of “corrugated plastic” and it is used as a replacement for cardboard in a wide variety of applications – a very good sign. There are a number of manufacturers (for a state by state listing see <http://www.thomasnet.com/products/plastic-sheet-sheeting-corrugated-60000551-1.html>) and many of these provide additional processing to create complex shapes. It has been used for solar cookers already (and of course household aluminum foil can be used as the reflecting material), though no information about very long term durability is yet known.
5. It is wise to consider both the materials choices and solar cooker design choices at the same time – without prior experience in manufacturing products from the components in the table we cannot be sure of the choices available for fabricating cookers from them. It is best to consult with component manufacturers, providing them with examples of existing designs and limitations on future ones, so that they can advise on gluing, cutting, joining, folding, etc. They may also provide fabrication services, and be surprisingly inexpensive.
6. It may be desirable or necessary to manufacture overseas – either in low cost countries (such as China or India) or in countries close to where the cookers are to be deployed (e.g. Africa) – and in the second case that may create restrictions on what materials are available. Because the suggested materials are all somewhat sophisticated, it would be best to investigate purchasing materials or manufacturing in a more technologically advanced country, such as South Africa, if there are restrictions on imports from the U.S. or similar. Determining materials sourcing and manufacturing locations, and the resulting materials constraints, as early in the design process as is possible is important.