The following are short excerpts from an out of print book, *Solar Domestic Hot Water,* by Russell Plante, 1983

Coatings

Absorptive coatings are of two types: selective and nonselective. A selective surface is a special coating that impedes the reradiation of infrared energy from the hot absorber plate, therefore retaining more heat to be transferred to the liquid media. The absorbtivity is high and emissivity is low. A nonselective coating, on the other hand, exhibits high absorbtivity and high emissivity. The higher the heating requirement, the more a selective surface is needed. Costs and an unknown life factor are items to consider. Systems that require 200° F and higher need selective coatings for efficient operation. Examples of absorptive coatings are illustrated in Table 4-4.

Table 4-4
Characteristics of Absorptive Coatings

Property / Material	Absorptance[1/] α	Emittance ϵ	$\frac{\alpha}{\epsilon}$	Breakdown Temperature °F (°C)	Comments
Black Chrome	.87-.93	.1	∼9		
Alkyd Enamel	.9	.9	1		Durability Limited at High Temperatures
Black Acrylic Paint	.92-.97	.84-.90	∼1		
Black Inorganic Paint	.89-.96	.86-.93	∼1		
Black Silicone Paint	.86-.94	.83-.89	∼1		Silicone Binder
PbS/Silicone Paint	.94	.4	2.5	662 (350)	Has a High Emittance for Thicknesses >10μm
Flat Black Paint	.95-.98	.89-.97	∼1		
Ceramic Enamel	.9	.5	1.8		Stable at High Temperatures
Black Zinc	.9	.1	9		
Copper Oxide over Aluminum	.93	.11	8.5	392 (200)	
Black Copper over Copper	.85-.90	.08-.12	7-11	842 (450)	Patinates with Moisture
Black Chrome over Nickel	.92-.94	.07-.12	8-13	842 (450)	Stable at High Temperatures
Black Nickel over Nickel	.93	.06	15	842 (450)	May be Influenced by Moisture at Elevated Temperatures
Ni-Zn-S over Nickel	.96	.97	14	536 (280)	
Black Iron over Steel	.90	.10	9		

1/ Dependent on thickness and vehicle to binder ratio.

G. E. McDonald, "Survey of Coatings for Solar Collectors", NASA TMX-71730, paper presented at Workshop on Solar Collectors for Heating and Cooling of Buildings, November 21-23, 1974, New York City.

G. E. McDonald, "Variation of Solar-Selective Properties of Black Chrome with Plating Time", NASA TMX-71731, May 1975.

S. W. Moore, J. D. Balcomb, J. C. Hedstrom, "Design and Testing of a Structurally Integrated Steel Solar Collector Unit Based on Expanded Flat Metal Plates", LA-UR-74-1093, paper presented at U. S. Section-ISES Meeting, Ft. Collins, Colorado, August 19-23, 1974.

D. P. Grimmer, S. W. Moore, "Practical Aspects of Solar Heating: A Review of Materials Use in Solar Heating Applications", paper presented at SAMPE Meeting, October 14-16, 1975, Hilton Inn.

R. B. Toenies, "Integrated Solar Energy Collector Final Summary Report", LA-6143-MS, Los Alamos Scientific Laboratory, Los Alamos, New Mexico, November 1975.

G. L. Merrill, "Solar Heating Proof-of-Concept Experiment for a Public School Building", Honeywell Inc., Minneapolis, Minnesota National Science Foundation Contract No. C-870.

D. L. Kirkpatrick, "Solar Collector Design and Performance Experience", for the Grover Cleveland School, Boston, Massachusetts, paper presented at Workshop on Solar Collectors for Heating and Cooling of Buildings, November 21-23, 1974, New York City.

Source. Intermediate Minimum Property Standards Supplement, 1977 Edition, U.S. Dept. of Housing and Urban Development.

To document and quantify the advantage of a selective surface, Olin Brass conducted a series of tests to compare collector performance, using black chrome versus black paint. The tests were performed by an independent laboratory, Desert Sunshine Exposure Testing (DSET), using American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) 93-77 procedures. Results of these tests included the following:

1. The black chrome-plated absorber showed higher collector efficiency as the temperature difference between absorber and environment increased. This comparison is illustrated in Figure 4-12.

2. Temperature differences between the fluid in the collector and the environment of 30° to 80° F are typical of summertime operation of solar domestic hot water systems. When the insolation is perpendicular to the collector surface, the advantage of the black chrome selective surface ranged from 4 to 10 percent for 300 BTU/ft²-hr, as depicted in Figure 4-13. As the angle of incident insolation increased relative to the collector surface, (i.e., morning and afternoon), the advantage of the selective surface increased from 8 to 35 percent or 200 BTU/ft²-hr.

Typical winter temperature differences between the fluid in the collector and the environment are still greater and may range from 75° to 100° F above the ambient temperature. The midday advantage of black chrome then becomes 22 to 46 percent for 300 BTU/ft²-hr. The morning and afternoon advantage then become 74 percent to well over 100 percent improvement.

3. The single glazed collector using black chrome-plated absorber was found to be effectively equivalent to the double glazed collector with black painted absorber at lower temperature differences but was found to be significantly better at higher temperature differences. This difference is shown in Figure 4-14 and illustrates that systems requiring higher temperature outputs (i.e., 200° F) need selective coatings for efficient operation.

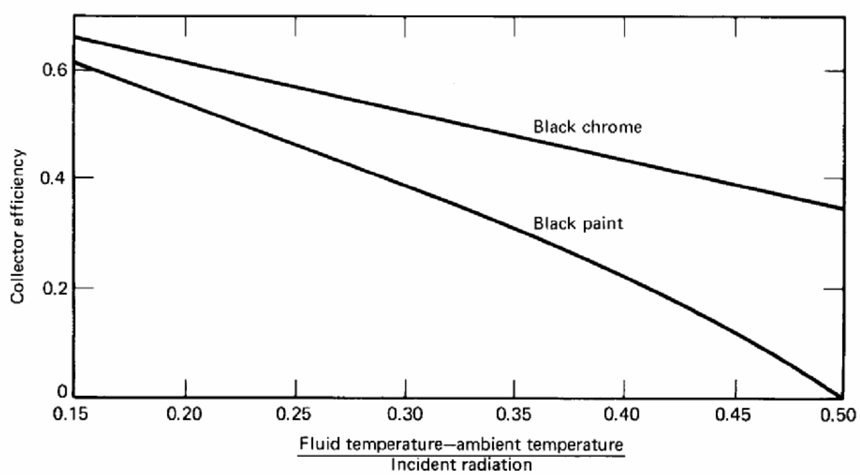

Figure 4-12. Efficiency of a single-glazed black chrome-plated collector versus single-glazed black paint. (Courtesy of Olin Brass Corp., East Alton, Ill.)

Figure 4-13. Relative performance improvement of a black chrome-plated absorber compared to black paint. (Courtesy of Olin Brass Co., East Alton, Ill.)

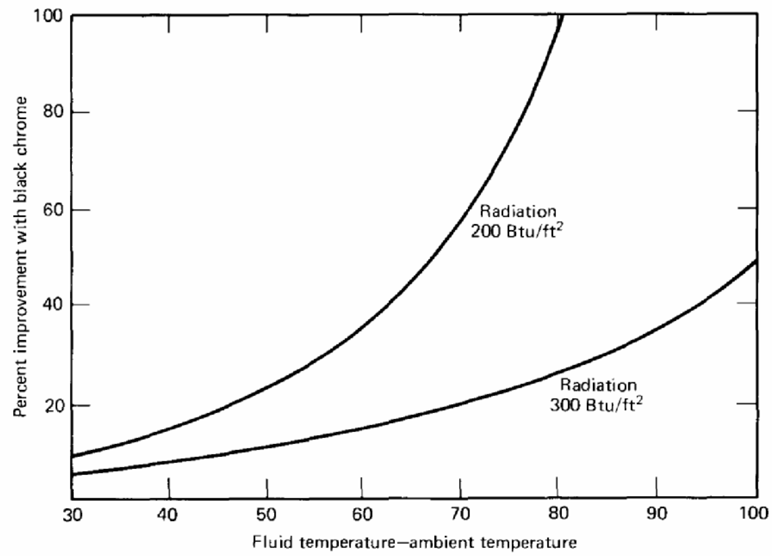

Figure 4-14. Efficiency of a single-glazed black chrome plated collector versus double-glazed black paint. (Courtesy of Olin Brass Co., East Alton, Ill.)