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SOLAR THERMAL MATERIALS RESEARCH AND DEVELOPMENT[1]

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The primary objectives of the Materials Research and Development effort are 1) to understand the behavior and interaction of different materials used in solar thermal technologies so as to create a sound technical base for future system and component designs and 2) to develop materials to extend the application potential of systems by either making materials more reliable in difficult operating environments or by offering lower cost alternatives to presently used materials.

Solar thermal systems are being designed aimed primarily at electric power, industrial process heat from low to high temperature, and fuels and chemicals applications. Another application not discussed here is building climate control such as passive and active heating and cooling. Systems which concentrate, collect, and transport solar thermal energy are of primary interest for these potential applications.

Concentration ratio corresponds to the ability of a solar collector to deliver high temperature thermal energy. Figure 1 shows the progression from point focusing systems (both parabolic dishes and heliostats), through line focusing systems such as parabolic troughs, CPC, evacuated tubes, to solar ponds. This figure depicts their primary application focus while also displaying other potential applications for which these systems may be equally well suited.

The materials research and development effort is divided in two categories: 1) optical materials which include reflectors, transmitters, and optical structures; and 2) thermal materials for receiver

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[1]This effort is managed by SERI for the U.S. DOE, Division of Solar Thermal Energy Systems

and energy transport subsystems which consist of absorber materials, ceramics, metals, alloys, and heat transfer fluids. The relative importance of materials in the two categories to the solar thermal systems of interest is also displayed in Figure 1, more dots meaning greater importance.

The materials requirements are derived from the system concepts and expected application environments. These requirements have been established for the current generation of solar thermal systems and the perceived needs of the initial markets. A great deal of effort remains to establish the systems requirements and market needs for systems that would have to meet the stringent first cost and economic criteria of the industrial sector where the larger potential may exist for modified versions of current or entirely new concepts of future solar thermal energy systems.

Materials research and development includes the four critical steps; namely, a) generating new ideas and concepts, b) assessment of its potential from economic and system performance viewpoints, c) pilot fabrication of promising materials and evaluation both in laboratory and field experiments, and d) adaptation of the new or improved materials to the wide range of components and systems. This program is structured to allow these steps to be conducted with a maximum utilization of the available university, national laboratories, and industrial scientific and production capabilities. With this combined effort it is hoped that the most promising concepts and materials nurtured through research and development will ultimately emerge in the commercial marketplace.

The development of optical materials has the highest priority because they account for a significant portion of the solar thermal system cost and also, being new and unique to solar systems, presents the

largest unknown in calculating their operational reliability and life cycle costs from the ultimate users perspective. Optical systems, which consist of reflecting, transmitting, and structural materials, when further developed, can lead to concentrators with lower initial cost, improved performance, or longer life. One of these criteria is important in each unique application or system depending on whether higher temperature, minimum maintenance, low first cost of installed systems or some combination is required by the purchaser of the system.

In the following, some examples of the research projects in the concept laboratory evaluation stages are polymers and mirrors. An example of the research at the concept stage is the development of polymers which are UV stable over a long period, say up to 10 years. Polymers offer the potential to reduce the cost or extend the life of a variety of solar energy systems. Another example is the evaluation of alternate mirror fabrication techniques which offer the possibility of more durable mirrors on glass and polymers.

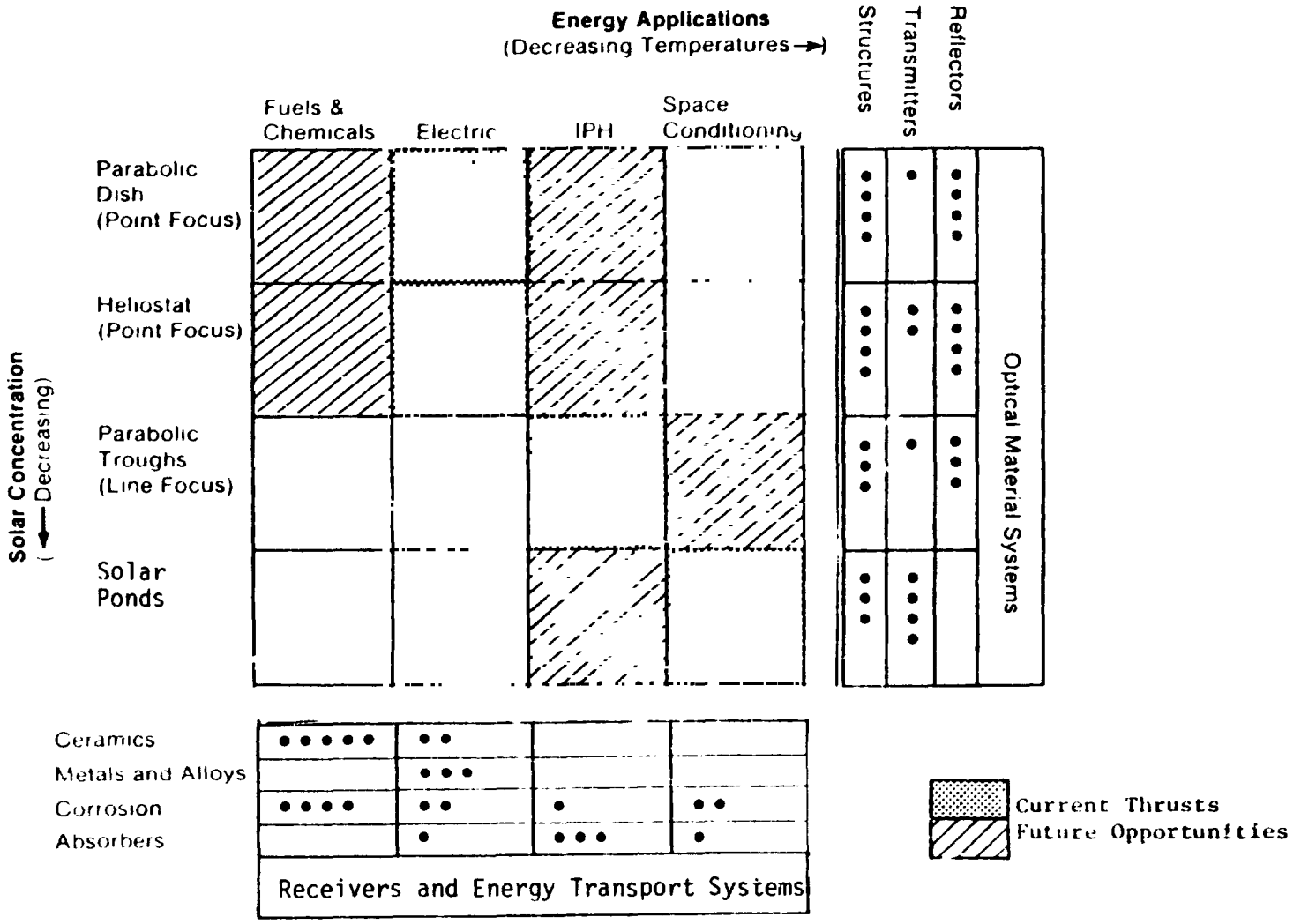
Examples of the materials in pilot fabrication and adaptation are cermet coatings and thin glass. A concept being assessed for its large scale production is the cermet selective absorber coating with platinum and aluminum oxide. This material, developed as a university concept, showed desirable performance characteristics in the laboratory and is now being evaluated by industry using production equipment and techniques.

The evaluation of thin glass produced by industry on a pilot production basis represents an example of another materials development effort. Glass with high transmission coupled with desirable characteristics such as good strength and low weight is undergoing field evaluation by a variety of solar system fabricators. This evaluation by equipment designers and system engineers is critical to the success of the materials research and development since this represents the initial

step to future product improvement and industry commitment for large scale production.

The materials development is a foundation upon which future solar systems will be built. Guiding the availability of these reliable materials with adequate data to designers and system suppliers through the commercial sector is the measure of success of this effort.

Figure 1



Materials Application to Solar Thermal Systems and Applications