Chimia 47 (1993) 407

ISSN 0009–4293

Polymers for Solar Energy

Helmuth Kiess*

The developments in the use of renewable energies have been remarkable in the last few years. In particular significant progress has been achieved in solar photovoltaic and solar thermal energy conversion. Since polymers are important materials employed in these technologies, it seems indicated to give account of the achievements and the problems faced with the use of polymers in solar energy conversion.

Polymers are used for packaging solar photovoltaic cells, for supports and protection of mirrors and as sealants. However, also research is conducted to explore organic and polymeric materials as photovoltaic materials. The hope is to profit from the flexibility of the organic chemistry which might allow to taylor solar cell material for optimal efficiency and to achieve eventually also a cost reduction.

Solar cells are usually assembled in units delivering a specified power (*e.g.* 50 W) under 1000 W/m^2 solar irradiation. These units are called modules or panels. The cells in the module have to be safely protected against corrosion and mechanical damage if a lifetime of power stations of at least 30 years is envisaged. The use of polymers for packaging and protection of the cells has, therefore, emerged as a most important technique for fabricating photovoltaic modules. The material requirements are stringent: The polymer has to be transparent in the wavelength range between 0.35 and *ca.* 1.5 µm and it has to be UV resistent. The optical properties should not degrade during the life of the module for *ca.* 30 years. The modules should withstand the exposure to the atmospheric gases and pollutants and to all possible climates, be it in a desert, in high humidity equatorial regions, or in mountains where cyclic temperature variations between –40 and +80° might occur in the extreme. These requirements to the polymer and to the fabrication technology proved to be non-trivial. The present technology is nearly exclusively based on the use of EVA (ethyl vinyl acetate) as embedding medium and, if glass is not employed as front cover or backing, Tefcel and Tedlar, respectively, are used instead of glass. Though satisfactory in general, certain problems arise in extreme climates, and in addition, experience does barely exist for modules being operated longer than 20 years.

Mirrors for concentrating solar radiation are usually made of silver films deposited on a protective backing and covered by a highly transparent superstrate. Polymers used for this purpose have to supply the abrasion, wear, diffusion and UV resistance in the ambient in which they are used. Obviously, aside of stable bulk also stable interfacial properties between silver and polymer are needed for a reliable operation and for the stability of the reflectance of the silver film.

The use of polymers as photo-active material is still in the laboratory stage. Conducting polymers and dyes have been used to construct solar cells in form of pn or *Schottky* junctions. The photo excitations in these materials, however, differ often from those in inorganic solids. The formation of excitons, exciplexes, polarons, and bipolarons may play an important role and reduce the generation efficiency for free carriers. Further problems are mobility and life time of the minority carriers and the life time of the devices. Basic investigations of the materials are required in order to be able to find solutions for an all-polymeric or organic solar energy conversion device. More recent approaches consider photosynthesis-type of charge generation and separation as a means to generate electrical power. However, whether a device competitive to conventional schemes can be realized is still an open question and requires further theoretical and experimental work.

**Correspondence*: PD Dr. H. Kiess
Paul Scherrer Institut
CH–5232 Villigen PSI