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KEY TECHNOLOGIES ON RENEWABLE MATERIALS AND ENERGY RESOURCES FOR PEACE AND SURVIVAL DIPLOMACY OF MANKIND ON THE EARTH

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Depending primarily on the energy resource and technology, the human civilization is classified into several generations: G1 (Hunting), G2 (Agricultural), G3 (Coal/Industrial: 18-19C), G4 (Electric/Electronic: 20C-), and G5~ (Quantum/Metaverse: IoT/AI, 21C). Recent progress in science and technology is so fast that it is providing us with not only future dreams but also fatal risks for our world by the dictators and autonomous domination of IoT/AI.

Here, we pick up 3 topics from our research carriers as long as 5 decades since 1970.

1. CO_2 copolymerization to produce bio-degradable plastics for contribution to SDGs.

2. Convert the deserts to PV energy mines with food supplying green fields.

3. Asia-Pacific to Atlantic trans-continental Super highway of PV and gas energies.

The topic-1 is based on Koinuma's Ph.D. research at Tokyo University. [1], while topics-2 and 3 are on the Sahara Solar Breeder (SSB) plan which was acknowledged by Sci. Council of Japan (SCJ) to propose to G8+5 Academies Conference in Rome (2009). SSB had been supported by JST-JICA as a global project to collaborate with Algeria (2010-2015) [2]. These topics, especially 2 and 3, appear to be Don-Quixotic [2, 3] but had favors by MENA and Turkmenistan academia for developing technologies of new solar Si and High-Tc superconducting dc-power transmission (SCDC) to inspire the engineers' spirit and technology of young students. Some details of the topics are summarized below.

1. CO_2 copolymerization to produce bio-degradable solid polymer/plastics.

Carbon dioxide is assigned a main criminal of global warming and is targeted to be reduced. A variety of policies, like carbon neutral and CCS (Carbon Capture and Storage), have been proposed, but their execution is severely restricted due to the narrowing of the natural gas supply from Russia accompanied by its invasion of Ukraine. Technologically the simplest CCS would be the direct fixation into solid and regeneration of CO_2 at appropriate time intervals. The alternating copolymerization of CO_2 with epoxides is a typical case and it was discovered in 1969 by H. Koinuma during his Ph.D. research at Tokyo University, published and patented in Japan and abroad [1]. The alternating polycarbonate sequence was verified by NMR and IR spectroscopies indicating that $ZnEt_2$-H_2O and other catalysts initiated the opening of the strained epoxide ring in combination with the C=O $\pi \rightarrow$C-O σ bond in CO_2 to form the carbonate bond spontaneously (figure 1).

Most of the copolymers with different substituents on epoxide could be purified by reprecipitation into a white soft solid with Mw as high as 400,000. which exhibited melting and degrading temperatures as low as 40℃ and about 200℃, respectively. They also had bio-

degradability as well. Thus, these CO_2 copolymers may be useful as CO_2 capture and storage: CCS material without forming micro-plastic pollution. For large-scale industrial production, although a few test plants were reported to exist in US and China, we need to improve the catalyst efficiency significantly and find good applications and markets. Since CO_2 and CS_2 copolymer work as electrolytes, they could be used for solid polymer batteries of EV. Other candidates for application include composites with inorganic solids (e.g. $CaCO_3$), polymer alloys, and plastics without forming micropollutants in the sea.

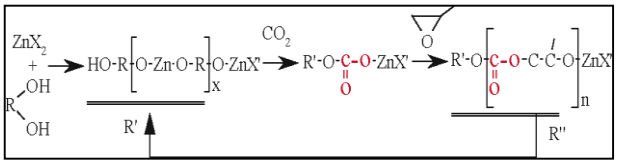


Figure 1. Alternating copolymerization of CO2/CS2 and epoxides to form Biodegradable/Electrolytic aliphatic polycarbonates and poly xanthates

2. Convert the deserts to PV energy mines with food supplying green fields.

The Sahara Solar Breeder: SSB project was a technical cooperation plan between Japanese and Algerian Universities for 5 years from 2010 in a framework of SATREPS (Sci. & Tech. Res. Partnership for Sustainable Development) supported by Japanese funding agencies: JST and JICA [2]. The main purpose and motivation of the SSB project were the following:

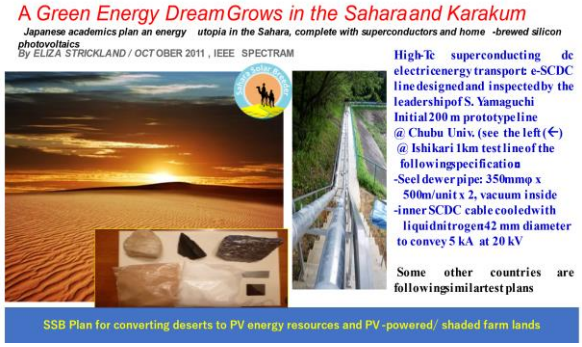
1. New Si technology for purifying and reducing desert sands to SOG-Si of 6+ nines purity as inexpensive mass production material of solar cells and PV panels to make shadows and GW-TW class power plants in the desert.
2. PV electricity is designed to be beneficial for local people to pump up water to make oases and agricultural lands, and amplify PV plants by the breeding mode using the extra electric power converted from the sunlight as infinitely-fed free fuel.
3. In parallel with the construction of solar breeder plants, SCDC transmission R & D should start to supply surplus energy to surrounding areas and globally in the future.

Shortly after the Rome conference, we got an invitation from the Turkmenistan Academy of Sciences (TAS) to the June 12 Science Day International Conference and Exhibition to deliver a talk on the SSB project. Apparently, TAS was interested in the SSB because of the Karakum desert, as big as the whole area of Japan, and the possibility of its change to rich energy resources. Later, we established JTSTC: Japanese-Turkmen Assoc. for Science and Technology Cooperation to start academic collaboration by signing the contract for fostering young Turkmen engineers and challenging together to advance research for the future. Natural gas, the origin of the richness of the permanent neutral country Turkmenistan, is not permanent but drying up in 50-100 years by using it as a fuel, even if its CO_2 emission is relatively lower than other fossil fuels. In order to stabilize this economically and politically fluctuating world as well as to bring peace to the world, the best solution is presumed to be a sufficient and fair energy supply to human beings. The spaceship earth is cruising in a steady state of energy flow from the sun that is a nuclear fusion reactor bringing solar energy 10,000 times as much as we are consuming, free of charge. Assuming the placement of solar panels with 10 % solar to electricity conversion efficiency, 1 km^2 and 100x100 km^2 desert can respectively be 100 MW and 1 TW power stations.

Technology tasks of SSB include:

1. The purification of desert sand and its energy-saving reduction to solar-grade silicon.
2. Innovative electric energy transmission by high-Tc superconducting cable.

Preliminary R & D have been proposed and tested in view of a variety of technological progress and international circumstances for spreading out the clean energy policy. Rather than



the technology, the diplomatic/economic factors coming from the incentive to avoid the nuclear and global environmental risks could trigger the paradigm shift. Japanese dominance in the solar cell industry until the early 21 century decayed and was taken over by clever Chinese business sense. SSB concept can be traced back to the virtual GENESIS proposal by Kuwano soon after the discovery of HTSC. It also can be compared with the current going Dii Energy consortium to transfer energy from the African desert to Europe using conventional HVDC technology. Based on our experience in energy science and technology since the 1980s, we hope to bring a renaissance of solar Si technology and innovation in energy transmission as well.

3. Asia-Pacific to Atlantic trans-continental SCDC highway of PV and gas energies.

The human population is supposed to have increased from less than one to eight billion during the past 200 years due mainly to Haber-Bosch's NH_3 synthesis from N_2 in the air and H_2. N is one of the 3 key elements, together with P and K, of fertilizer to produce the foods as raw materials to constitute organic living things including human beings, plants, seaweeds, bacteria, and viruses. Photosynthesis is another typical case of chemical conversion of inorganic, non-living to organic living things with the assistance of solar light. Our and every living thing's life is filled with many chemical reactions by the catalysis of enzymes and driven by the exchange of various types of energy. The key technology in our life exists not only in energy resources but also in their supply chains. Natural gas resources in Turkmenistan are mainly exported to China and Russia via gas pipelines. From the viewpoint of low loss and high security, we propose the SCDC scheme of SSB. As a result of Ishikari's 1km SCDC project, the leading status of Japanese technology in this respect was recognized [3]. The fierce race toward SCDC-type power transmission is prospected to start internationally. Preliminary SSB research with Algeria can be extended to cooperation with Turkmenistan and MENA countries to stabilize and balance the energy needs in the world. SCDC's future technology could present a possibility for Turkmenistan to possess the third and the safer efficient way of natural gas energy transport by replacing it with the current gas pipeline (and LNG tanker). Some more details will be reported elsewhere.

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