

Material which can Store Energy From The Sun For Months or Even Years – A Spiritual Insight

By MATSATI - December 19, 2020



Renewable energy is the goal of the future, and scientists are trying to find better ways of efficiently storing energy until it is needed for future use. A recently published paper [1] in the Journal of Chemistry of Materials, have identified a good candidate for the application of energy storage using solar energy.

References

1. *Kieran Griffiths, Nathan R. Halcovitch, and John M. Griffin**, "**Long-Term Solar Energy Storage under Ambient Conditions in a MOF-Based Solid-Solid Phase-Change Material,**" *Chem. Mater.* 2020, 32, 23, 9925–9936, <https://pubs.acs.org/doi/10.1021/acs.chemmater.0c02708>

The material of choice scientists used is the metal-organic framework (MOF), which is a highly structured material, carbon-based molecules which link metal ions forming a porous and well defined structured material. Due to the porous nature of the material, it is possible to incorporate other small molecules in the material. This is what the research team did adding molecules that absorb energy from the electromagnetic spectrum of ultraviolet light. The research paper describes the MOF materials as containing photoswitches within the pores to form a hybrid solar thermal fuel by the mechanism of a solid-solid phase change material azobenzene. The scientists used X-ray powder diffraction, solid-state NMR, and density functional theory (DFT) to characterize the materials. DFT was used to explore the possible structural changes of the azobenzene+MOF composite material as a function of loading different concentrations of the guest molecule in MOF. Upon irradiation with 365 nm light, 40% of the guests molecules converted from the trans to the higher-energy cis isomeric form. The energy stored within the metastable cis isomers is released upon heating and balances the endotherm associated with the phase transition. However, the

exotherm associated with the phase transition is retained upon cooling, resulting in a net energy release over a full heating-cooling cycle.

The researchers studied the trends under different loadings of the MOF material, and the maximum energy density was observed for the fully loaded (100%) composite which releases 28.9 J/g. In addition, the cis-form of the guest molecule showed negligible thermal reconversion during 4 months at ambient temperature, with an estimated energy storage half-life of 4.5 years. This is a significant achievement. This material has the capability of capturing the free energy in the UV spectrum from the sun and storing this energy for a very long time. Applying heat to the material results in a quick release of the stored energy (azobenzene exothermically switches from cis to trans conformation). The energy density of this phase transmission is not especially significant, so it will not drive future power stations, but there are other applications where low-grade heat is needed. Past efforts in this area of research was in the liquid phase materials. This material offers the solid phase option in the design process and allows for much easier use of the material for practical applications. As it stands, more work is needed to get this composite MOF material ready for widespread use. While tests showed it could hold on to energy for months at a time, the energy density of the material is relatively low, which is one area the researchers are hoping to improve on. The good news is the researchers state that they have ideas on how to tweak (improve) the results which are the current efforts of the research team. They say there are a number of ways to optimize these materials and so they are currently working on this material as a possible cost-effective and reliable way of storing energy in the future in applications for solar energy conversion and storage, and thermal management in low-grade heating applications.

The Spiritual insights that we receive from this type of research is related to this idea of energy storage and the sun. The second law of thermodynamics states that the total entropy of an isolated system can never decrease over time, and is constant if and only if all processes are reversible. Isolated systems spontaneously evolve towards thermodynamic equilibrium which is the state that is described as maximum entropy. This concept of entropy is the thermodynamic quantity representing the unavailability of a system's thermal energy for conversion into mechanical work, often interpreted as the degree of disorder or randomness in the system. In the Scientific research scientists are designing a material that will lead to highly ordered and structured material, when absorbing energy from the sun, will convert to an state of the material, a conformation of azobenzene shifting from trans to cis which is more thermodynamically unstable. This cis-conformational state is exothermic (releasing heat) when azobenzene shifts from cis- to trans-conformation. The sensible heat may then be used in the application of low-grade heating. Materials like this are specifically designed for this application. In general though, when a material is exposed to electromagnetic radiation like from the sun, over time the material degrades and the entropic level of the material increases, meaning that the material is moving towards decay, disorder, as the Bible says, "and to dust you shall return" (Bereshit / Genesis 3:19) meaning as entropy increases, these materials, even you and I will return to our base elements. This is the aspect we want to discuss today in relation to the following verses.

מגילת קהלת פרק א

א דבְּרִי קִהְלֵת בְּ-דָוִד מֶלֶךְ בִּירוּשָׁלַם: ב הַבַּל הַבָּלִים אָמַר קִהְלֵת הַבַּל הַבָּלִים
הַפֶּל הַבָּל: ג מֵ-יִתְרוֹן לָאָדָם בְּכָל-עֲמָלוֹ שְׂיַעֲמַל תַּחַת הַשֶּׁמֶשׁ: ד דוֹר הַלֶּךְ וְדוֹר
בָּא וְהָאָרֶץ לְעוֹלָם עֹמֶדֶת: ה וְזָרַח הַשֶּׁמֶשׁ וּבָא הַשֶּׁמֶשׁ וְאֵל-מְקוֹמוֹ שׂוֹאֵף זֹרֵחַ הוּא
שָׁם: ו הוֹלֵךְ אֶל-דְּרוֹם וְסוֹבֵב אֶל-צָפוֹן סוֹבֵב / סָבֵב הוֹלֵךְ הַרוּחַ וְעַל-סְבִיבֹתָיו שָׁב
הַרוּחַ: ז כָּל-הַנְּחָלִים הַלְּכִים אֶל-הַיָּם וְהַיָּם אֵינָנוּ מֵלֵא אֶל-מְקוֹם שֶׁהַנְּחָלִים הַלְּכִים
שָׁם הֵם שָׁבִים לְלֶכֶת: ח כָּל-הַדְּבָרִים יִגְעִים לֹא-יִוָּכַל אִישׁ לְדַבֵּר לֹא-תִשָּׁבַע עַיִן
לְרֹאוֹת וְלֹא-תִמְלֵא אֶזְנוֹ מִשְׁמַע: ט מֵ-שִׁהִיָּה הוּא שִׁהִיָּה וּמֵ-שִׁנְעָשָׂה הוּא
שְׂיַעֲשָׂה וְאֵין כָּל-חֲדָשׁ תַּחַת הַשֶּׁמֶשׁ

ECCLESIASTES 1:1-9

1:1 THE WORDS OF THE PREACHER, THE SON OF DAVID, KING IN JERUSALEM. 1:2 'VANITY OF VANITIES,' SAYS THE PREACHER, 'VANITY OF VANITIES! ALL IS VANITY.' 1:3 WHAT ADVANTAGE DOES MAN HAVE IN ALL HIS WORK WHICH HE DOES UNDER THE SUN? 1:4 A GENERATION GOES AND A GENERATION COMES, BUT THE EARTH REMAINS FOREVER. 1:5 ALSO, THE SUN RISES AND THE SUN SETS; AND HASTENING TO ITS PLACE IT RISES THERE AGAIN. 1:6 BLOWING TOWARD THE SOUTH, THEN TURNING TOWARD THE NORTH, THE WIND CONTINUES SWIRLING ALONG; AND ON ITS CIRCULAR COURSES THE WIND RETURNS. 1:7 ALL THE RIVERS FLOW INTO THE SEA, YET THE SEA IS NOT FULL. TO THE PLACE WHERE THE RIVERS FLOW, THERE THEY FLOW AGAIN. 1:8 ALL THINGS ARE WEARISOME; MAN IS NOT ABLE TO TELL IT. THE EYE IS NOT SATISFIED WITH SEEING, NOR IS THE EAR FILLED WITH HEARING. 1:9 THAT WHICH HAS BEEN IS THAT WHICH WILL BE, AND THAT WHICH HAS BEEN DONE IS THAT WHICH WILL BE DONE. SO THERE IS NOTHING NEW UNDER THE SUN. (NASB)

ספר תהילים פרק קב

:יב יְמֵי כְּצֶלְ נְטוּי וְאֲנִי כְּעֶשֶׂב אֵיבֹשׁ: יג וְאַתָּה יְהוָה לְעוֹלָם תִּשָּׁב וְזָכְרְךָ לְדוֹר וָדוֹר

TEHILLIM / PSALMS 102:11-12

102:11 MY DAYS ARE LIKE A LENGTHENED SHADOW, AND I WITHER AWAY LIKE GRASS. 102:12 BUT YOU, O LORD, ABIDE FOREVER, AND YOUR NAME TO ALL GENERATIONS. (NASB)

ספר תהילים פרק קט

כב: כִּי-עֲנִי וְאֶבְיוֹן אֲנִי וְלִבִּי חָלַל בְּקִרְבִּי: כג: כָּצַל כְּנִטּוֹתַי נִהְלַכְתִּי נִנְעַרְתִּי כְּאַרְבֶּה:

TEHILLIM / PSALMS 109:22-23

109:22 FOR I AM AFFLICTED AND NEEDY, AND MY HEART IS WOUNDED WITHIN ME. 109:23 I AM PASSING LIKE A SHADOW WHEN IT LENGTHENS; I AM SHAKEN OFF LIKE THE LOCUST. (NASB)

In [Ecclesiastes 1](#), these are sobering words and Solomon is saying that ultimately, our end is death. Because our end is death, our bodies cease to exist, we question our lives and our existence in this world. Solomon states, *מה-יתרון לאדם בכל-עמלו ושיעמל תחת השמש* **"What advantage does man have in all his work Which he does under the sun?"** Because of our eventual death, all of the things that we chase in life, wealth, acquiring things, pleasures, all of these are vanishing and by the end of our lives appears to be simply chasing after the wind. This is what Solomon calls Havel Havalim (הבל הבלים) **"vanity of vanities."** These things speak to the fleeting nature of our lives. The Psalmists states according to [Tehillim / Psalms 102:11](#), *מי כצל נטי ואני כעשב איהש*, **"My days are like a lengthened shadow, And I wither away like grass"** and in [Tehillim / Psalms 109:23](#), *כצל כנטותו נהלכתי ננערתי כארבה*, **"I am passing like a shadow when it lengthens; I am shaken off like the locust."** These things speak to the passing nature of our lives, we work, we live, we aspire for things, and in the end they are all truly of little value. The Apostle James said something very similar most likely calling upon the words of Solomon saying in [James 4:14](#) **Why, you do not even know what will happen tomorrow. What is your life? You are a mist that appears for a little while and then vanishes. (NASB)** These things speak to the scientific research where scientists are designing a material that will lead to highly ordered and structured material, when absorbing energy from the sun, will convert azobenzene from trans-conformation to cis-conformation which is more thermodynamically unstable. The cis-conformational state being exothermic (releasing heat) when converting from cis- to trans-. The sensible heat may then be used in the application of low-grade heating. Here we find Solomon speaking of the things that we acquire under the sun, this is an attempt to store up wealth (note the parallel to the research). Yeshua spoke of these things in [Matthew 6:20](#) saying, **"Store your treasures in heaven, where moths and rust cannot destroy, and thieves do not break in and steal. English Standard Version. but lay up for yourselves treasures in heaven, where neither moth nor rust destroys and where thieves do not break in and steal."** He spoke in relation to the Torah, to be kind to others, to love God, to love others, and to offer charity to those who are in need, and saying this will cause treasure to be stored up in heaven. Yeshua taught us to reevaluate our lives and to focus upon our relationship with God and with others. The Psalmist states that the Lord God in heaven however is forever! ([Tehillim / Psalms 102:12](#)) and this is how treasure may be stored up in heaven, as opposed to this world where the laws of thermodynamics lead to rot and decay. The Lord God is eternal, this is why the word **"age" or "world,"** Olam (עולם) is used in the descriptions of who He is and note also that this word is derived from the root word (עלם) meaning **"to conceal" or "to hide."** This word speaks of a measure of time when used in the sense of **"age/eternity"** and speaks to how God conceals Himself as being eternal and our being finite beings. Because we are finite beings, we naturally have trouble comprehending the eternal nature of God. Our finite nature, our having a beginning and an end, this reminds us how we are called to

direct our lives to perform Teshuvah (repentance) meaning to turn from our sins. Note also how פָּנָיו which means "His face" referencing God (Tehillim / Psalms 105:4, דַּרְשׁוּ יְהוָה וְעִזּוּ בְּקִשׁוֹ פָּנָיו תִּמְיֵד Seek the LORD and His strength; Seek His face continually. NASB) its gematria is the same as that for the word עוֹלָם. This is why when we seek the face of God, these concepts of time, age, conceal, hidden, are drawn into context and these things cause us to know the purpose of our lives which is finite. Our purpose is to serve the Mighty One who is in heaven!

These things reveal to us what the author of Hebrews meant when he said [Hebrews 9:27](#) *"And as it is appointed unto men once to die, but after this the judgment. The fixed order for all men is to die once only, and to be judged after death. When they die, finality is stamped, on their life work."* (NASB) Which means this life is a test and it is the Lord God Almighty who guides us and calls us to Him. For those who love the Lord they will overcome, and those who love the things of the world will perish. The Scientific research draws these things out for us in the sense of what exactly are we storing up for ourselves in this world, and what we do in our lives, whether we live by faith or not will determine what is stored up in the Olam Haba (World to come)? Because of the Laws of Thermodynamics, it takes work to convert heat into usable energy. This reminds us how death is the central concept in the human lifecycle. This is why many today are trying to find the solution to death in technologies such as the brain-computer interface in the hopes of overcoming death and living forever. (i.e. let's just upload our minds to the cloud and live forever, kind of attitude. Note that a google search will find many people desiring this form of eternal life and science fiction series like "the 100" help perpetuate these kinds of things.) This is where the resurrection of Yeshua becomes most important as restoring what was originally intended by God's design to live forever. The Love of God is greater than death, and the mercy of God overcomes justice that is required due to sin. The Sacrifice of Yeshua is what provides atonement before God and forgiveness of sins, and these things are eternal, due to the eternality of God Himself and of Yeshua overcoming death and forever interceding on our behalf. ([Hebrews 4:15](#), [Hebrews 7:24-25](#)) Yeshua vindicated us, he causes us to live by the power of His Spirit, to have life and life more abundantly, because we are told that He (God our Father in heaven) has made us alive together with the Messiah! ([Ephesians 2:5](#), [Colossians 2:13](#)) The promise of the resurrection is for those who believe in Yeshua and live their lives for Him. The resurrection is said to give us a new body, one without sin, and restore to us eternal righteousness and innocence before God in the world to come. The creation groans and laments for the coming of the Messiah and restoration of the world from its fallen state ([Romans 8:22](#)). Yeshua suffered and died for this purpose, and death now has no hold over him. ([Romans 6:9](#), [Hebrews 7:25](#)) The Scientific research demonstrates for us the amount of work that goes into storing energy for future use which requires a molecular level of understanding in order to improve efficiencies and maximize the materials ability to store energy. The insights we receive from this type of research is what Solomon calls Havel Havalim (הַבֵּל הַבָּלִים) *"vanity of vanities"* of this world and of how much work we put into storing up treasures in our live. Vanity has an end, and this end affects the entire universe. The completion of God's plan, the hope of salvation, will literally affect everything as we know it, all of creation. In the great day of the Lord, all of creation will be set free from its bondage of corruption and receive the peace and joy of the glory of God ([Romans 8:20-21](#)). This is the hope that we look forward to! This hope can only be found in Yeshua the Messiah and our faith in Him!

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Dr. Duane D. Miller received his Ph.D., M.S., and B.S. Degree in Chemical Engineering from The University of Akron Ohio. He is currently a Chemical Engineering Researcher. Duane's research expertise has focused upon functional materials development for the control, conversion, and release of process gases in Energy production technologies. His R&D interests include computational chemistry, developing novel technologies for converting biomass to fuels and studying their fundamental interactions during the chemical conversion process. His past experience includes sorbent development for pre- and post-combustion CO₂ and SO₂ capture, selective absorption of H₂S from methane streams, O₂ capture for oxy-fuel combustion, photocatalytic reduction of alcohols, NO_x reduction catalysis, the development of oxygen carriers to combust fossil fuels (CH₄ and coal) for the chemical looping combustion processes, and the extraction of rare earth elements using patent pending sorbents. His research expertise has focused on operando-characterization using Infrared, Raman, and UV-Vis spectroscopy to observe the nature of the catalytic active sites and reaction intermediates under realistic reaction conditions, allowing direct correlation of molecular/electronic structures with catalyst performance during Gas-Solid / Liquid-Solid Adsorption and Photocatalytic Processes with real time online analysis of reaction products using ICP-MS and mass spectrometry. His current work involves a multi-disciplinary approach to developing, understanding, and improving the catalytic gasification of coal and methane, high temperature chemical looping combustion, and the catalytic decomposition and gasification of biomass and coal using novel microwave reactor. He has been studying the Hebrew Scriptures and the Torah for 20+ years and sharing what he has learned. The studies developed for MATSATI.COM are freely to be used by everyone, to God be the Glory!

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