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Defects in Cu(In,Ga)Se₂ thin-film solar cells

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Chalcopyrite Cu(In_{1-x}Ga_x)Se₂ (CIGS) alloy has got much attention due to its potentials to realize high-efficiency thin-film solar-cells. In addition to mega-solar power plants, CIGS thin-film solar cell module is also expected to be utilized in building walls and vehicles as power generation sources. Moreover, high optical absorption of the CIGS makes it possible to get required efficiency with thin film, thus, reduce the material cost. Quaternary CIGS is a pseudo-binary alloy of ternary CuInSe₂ ($x = 0$) and CuGaSe₂ ($x = 1.0$). Band-gap of the CIGS can be controlled by varying the Ga-content, $x = [\text{Ga}]/([\text{Ga}]+[\text{In}]) = \text{Ga/III}$ in the material, while it becomes 1.68 eV for CuGaSe₂. Band-gap of the CuGaSe₂ is close to the ideal band-gap of the absorber-layer to achieve highest possible efficiency with single junction solar cell under AM 1.5 sunlight.

Nevertheless, the performance of CIGS-based thin-film solar cells is influenced by Ga concentration of the films. In this study, we investigated the defect properties of Cu(In,Ga)Se₂ with Ga/(In+Ga) (Ga/III ratio) by photocapacitance spectroscopy measurements. We will discuss how defects at 0.8 eV from valence band maximum affect the solar cell performances.

Yashil kimyo – bu kimyoviy tajriba va ishlab chiqarishlar uchun zamonaviy mafkuradir

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"Yashil kimyo" – Kimyoviy reaksiyalar amalga oshishi uchun qattiq sharoit (yuqori temperatura va bosim) talab qilinmaydigan, reaksiya natijasida zaharli moddalar hosil bo'lmaydigan va atrof-muhitga zararli moddalar ajralib chiqarmaydigan kimyoviy jarayonlarni ifodalaydi. Boshqacha aytganda "yashil" kimyogarlar amalga oshirayotgan reaksiyalar o'simliklar va hayvonlar organizmlaridagi reaksiyalarga yaqin bo'lishlari kerak. Bunga misol qilib, azotobakteriyalarning dukkakli o'simliklar tomirida azotni oddiy sharoitda to'play olishini keltirish mumkin. Bu azotdan foydalanib dukkaklilar keyin oqsillarni hosil qiladi. Hozirgi kimyo sanoatida esa ammiak olish uchun havo tarkibidan azotni olishga juda yuqori bosim (30 atm. bosimgacha) va 500⁰C harorat talab etiladi.

Hozirgi vaqtda kimyoviy tadqiqotlardagi ustuvor yo'nalishlaridan biri "Yashil" kimyo (Green Chemistry) nomini olgan jarayonlar hisoblanadi. Bu eng avvalo barcha amalga oshiriladigan kimyoviy reaksiyalar atrof-muhit uchun qulay bo'lgan sharoitlarda kechishi lozim bo'lishi demakdir. Masalan, oksidlanish jarayonlarini amalga oshirish kerak bo'lsa, ularda oksidlovchi sifatida havo kislorodi qo'llanilsa, erituvchi sifatida suv ishlatiladigan kimyoviy jarayonlar yoki organik va mineral kislotalar (H₂SO₄, HCl va b.) o'rniga karbonat angidrid ishlatilishi nazarda tutiladi.

Shu asnoda "Yashil" kimyo atrof-muhitning ifloslanishini oldini olib, zaharsiz moddalar bilan ish ko'radi, hamda bu xavfni to'lig'icha yo'qotadi.

Bugungi kunda "Yashil kimyo" ning uchta yo'nalishini ko'rsatish mumkin, bular – sintezning yangi yo'llari (katalizatorlar yordamida), qayta tiklanadigan dastlabki reagentlardan foydalanish (neft mahsulotlaridan foydalanmaslik) va an'anaviy organik erituvchilardan foydalanmaslikdan iborat ekanligidir. Bir so'z bilan aytganda, bu qarash eng avvalo kimyoviy ishlab chiqarishlarda mavjud bo'lgan atrof-muhitga ajralib chiqayotgan turli xil zaharli moddalarni yo'qotishga qaratilgan bo'lib, uning natijasida insonlar yashab turgan muhit yaxshilanadi va ekologiyamizning musaffoligiga olib keladi. Shuni alohida ta'kidlash lozimki, "Yashil kimyo" – bu kimyoning birorta ilmiy bo'limi hisoblanmay, balki kimyoviy fikrlashning yangi usuli bo'lib, amalga oshirilayotgan kimyoviy tajriba va ishlab chiqarishlar uchun zamonaviy mafkuradir. Kichik kimyoviy laboratoriya ishlaridan tortib ulkan sanoat korxonalarida amalga oshirilayotgan jarayonlarda ham shu mafkuraga amal qilinishi kerak.

"Yashil " kimyo – yuqori darajada fanlar kesimi orasidagi bilimlar sohasi hisoblanadi. U organik kimyo bilan (yangi va alternativ sintetik usullar), anorganik kimyo bilan (yangi materiallar va katalizatorlar ochish), fizikaviy kimyo (erituvchilar xossalari), analitik kimyo (moddalarni aniqlashning selektiv usullari) sanoat kimyosi va kimyoviy muhandislik (mavjud kimyoviy jarayonlarni modifikasiyalash), iqtisodiyot fani bilan (kimyoviy mahsulotlar va materiallar analizi) toksikologiya, mikrobiologiya va biokimyo (fermentlash, biotexnologiya, gen muhandisligi), qishloq xo'jalik fanlari (qayta tiklanadigan xom – ashyo), ekologiya va huquq (Davlat boshqaruvi va nazorat) fanlari bilan ham kesishadi va ko'rsatib o'tilgan masalalarni birgalikda yechimini topishga xizmat qiladi.

Xulosa o'rnida shuni aytish mumkinki, kimyogarlarning "Yashil kimyo"ni o'rganishi, O'zbekiston barqaror taraqqiyotining omillaridan biri bo'lib hisoblanadi.

CONTENT

Defects in Cu(In,Ga)Se ₂ thin-film solar cells	
Takeaki Sakurai	1
Green Mining -Mining and Beyond	
Takashi Sasaoka, Hideki Shimada, Akihiro Hamanaka	2
Recent development on copper flotation and hydrometallurgy	
Hajime Miki	3
Studies on in-situ generation of CH ₄ and/or H ₂ using oil reservoir	
Yuichi Sugai	4
Investigation of iron oxide formation during roasting of Bioleaching tailings in the production of gold	
Hayrullo Hamidov, Omon Fuzaylov, Jahongir Narzullayev, Rustam Khamidov, Oybek Ashurov, and Kuvandik Sanakulov	5
Roll of fuels in a sustainable energy and environmental systems	
Toshihisa Ueda	6
Recent Advances in Health-Related Atmospheric and Environmental Research	
Tomoaki Okuda	7
Hydrogen Boride Nanosheets: Safe, Light-Weight, and Light-Responsive Hydrogen Carriers	
Masahiro Miyauchi, Reiya Kawamura, Akira Yamaguchi, Takahiro Kondo	8
Use of bentonite clays to increase the efficiency of the heap leaching of gold	
Sanakulov K.	9
Investigation of extracting REE compounds from underground leaching solutions	
Sharafutdinov U.Z., Kurbanov M.A., Ganieva D.S., Eshonova G., Radzhabova M.K., Khalilova I.R.	10
The promise up-conversion luminescence materials	
E. Trusova	11
"Green Chemistry" as a new conceptual system development of chemical science	
Sergey D. Aronbaev, Abdullo M. Nasimov, Dmitry M. Aronbaev	12
Formation of flexible fragmented molecules based on <i>O</i> -alkylation of Gossypol	
M. O'ktamova, D. Turgunov, S. Yuldasheva, K. Torikai, A. Eshimbetov, K.U. Khodjanliyazov	13
Gossypol behavior in Tishchenko reaction conditions	
S. Zamanbekova, D. Turgunov, S. Beshimova, K. Torikai, A. Eshimbetov, K.U. Khodjanliyazov	14
Formation of highly conductive ionic liquid doped on MoTe ₂ FET	
Kamoladdin Saidov, Jamoliddin Razzokov, Abdurasul Yarbekov, and Olim Ruzimuradov	15
State support of the "Green Economy" in the Republic of Uzbekistan	
Abdurashidova Marina Sagatovna	16

Цианур кислотанинг мочеви́на ва тиомочеви́на алмашинган ҳосилалари синтези ва ИҚ-спектрлари Б.Ш. Ганиев, Ў.М. Мардонов, Ф.С. Аслонова, Ж.М. Ашуров	51
Силикагелни диэтаноламин билан модификациялаш	
Гелдиев Ю.А., Тўраев Х.Х., Умбаров И.А., Эшмуродов Х.Э., Джалилов Т.А.	52
Effect of pH on the Ce (III) sorption	
Khakimboeva D.I., Daminova Sh.Sh., Kadirova Z.Ch., Shoyakubov D.T.^a	53
Qurilish g'ishtini ishlab chiqarishda xom ashyolarni qiyosiy o'rganish	
Xamidova Habiba Murat qizi	54
Analysis of technological sources of error of gear wheels, ways of increasing their accuracy	
Khamroev Nurbek Nurilloevich	55
Study of oligomeral antiseptics that protect wood materials from termitis research of oligomeral antiseptics that protect wood materials from termites	
A.I. Kholboeva , Kh.Kh. Turaev, F.N. Nurkulov , U.U. Ruziyev, I.D.Norqobilova	56
Electron microscopic analysis of wood materials treated with refractory materials	
A.I. Kholboeva, Kh.Kh. Turaev , A.T.Djalilov, F.N. Nurkulov, I.D.Norqobilova	57
Твердофазный синтез координационных соединений никотината меди(II)	
Ибрагимова М.Р., Азизов Т.А.	58
O'simliklarga rang beruvchi flavonoidlarni aniqlash uchun sezgir bo'lgan kimyoviy reaksiyalar	
Ismatov Davlat Muxiddin o'g'li, Muhamadiyev Nurali Qurbanaliyevich	59
Оптимизация состава и структуры износостойких белых чугунов	
А.А. Жумаев, Ю.Н. Мансуров, Х.И. Ахмедов^a	60
Керамические красители на основе минерального сырья Узбекистана и промышленных отходов	
Д.С.Кадирова, Н.А.Максудова	61
Prospects for the secondary use of nuclear fuel	
Karshiboev A.I., Khamidov A.A., Rasulova B.I., Vinokurova A.N.	62
The effect of water on the quality of cocoon and raw silk in the silk industry	
Qodirov Z.A., Sulaymonov Sh.A., Shakirov B.B.	63
Выделение алкалоидов конвольвина и конволамина из корней <i>Convolvulus subhirsutus</i>	
Д.Б. Кадирова, Н.И. Мукаррамов, С.Ф. Арипова	64
Yashil kimyo – bu kimyoviy tajriba va ishlab chiqarishlar uchun zamonaviy mafkuradir	
Qodirova Z.K., Sulaymonova Z.A.	65
Синтез сорбента на основе ковалентно иммобилизованного дитиокарбамата цинка на полиэфирной матрице	
Касимов Ш.А., Тураев Х.Х., Хамроева М.Ф., Джалилов А.Т.	66
Исследование влияние соотношения исходных веществ на сорбционных свойств полученного сорбента	
Касимов Ш.А., Тураев Х.Х., Хамроева М.Ф., Джалилов А.Т.	67