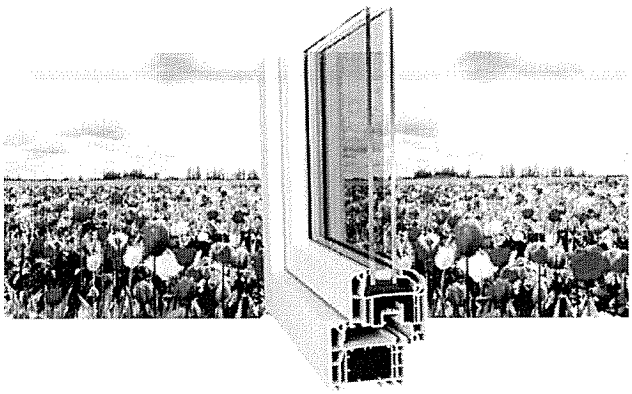
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Quantum dot solar windows go non-toxic, colorless, with record efficiency

25 August 2015



The luminescent solar concentrator could turn any window into a daytime power source.

A luminescent solar concentrator is an emerging sunlight harvesting technology that has the potential to disrupt the way we think about energy; It could turn any window into a daytime power source.

"In these devices, a fraction of light transmitted through the window is absorbed by nanosized particles (semiconductor quantum dots) dispersed in a glass window, re-emitted at the infrared wavelength invisible to the human eye, and wave-guided to a solar cell at the edge of the window," said Victor Klimov, lead researcher on the project at the Department of Energy's Los Alamos National Laboratory. "Using this design, a nearly transparent window becomes an electrical generator, one that can power your room's air conditioner on a hot day or a heater on a cold one."

This is what becomes possible with new devices – quantum dot LSCs –which will be available in the journal *Nature Nanotechnology* in the study "Highly efficient large-area colourless luminescent solar concentrators using heavy-metal-free colloidal quantum dots". The work was performed by researchers at the Center for Advanced Solar Photophysics (CASP) of Los Alamos, led by Klimov and the research team coordinated by Sergio Brovelli and Francesco Meinardi of the Department of Materials Science of the University of Milan-Bicocca (UNIMIB) in Italy.

In April 2014, using special composite quantum dots, the American-Italian collaboration demonstrated the first example of large-area luminescent solar concentrators free from reabsorption losses of the guided light by the nanoparticles. This represented a fundamental advancement with respect to the earlier technology, which was based on organic emitters that allowed for the realization of concentrators of only a few centimeters in size.

However, the quantum dots used in previous proof-of-principle devices were still unsuitable for real-world applications, as they were based on the toxic heavy metal cadmium and were capable of absorbing only a small portion of the solar light. This resulted in limited light-harvesting efficiency and strong yellow/red coloring of the concentrators, which complicated their application in residential environments.

Klimov, CASP's director, explained how the updated approach solves the coloring problem: "Our new devices use quantum dots of a complex composition which includes copper (Cu), indium (In), selenium (Se) and sulfur (S). This composition is often abbreviated as CISeS. Importantly, these particles do not contain any toxic metals that are typically present in previously demonstrated LSCs."

"Furthermore," Klimov noted, "the CISeS quantum dots provide a uniform coverage of the solar spectrum, thus adding only a neutral tint to a window without introducing any distortion to perceived colors. In addition, their near-infrared

emission is invisible to a human eye, but at the same time is ideally suited for most common solar cells based on silicon."

Francesco Meinardi, professor of Physics at UNIMIB, described the emerging work, noting, "In order for this technology to leave the research laboratories and reach its full potential in sustainable architecture, it is necessary to realize non-toxic concentrators capable of harvesting the whole solar spectrum."

"We must still preserve the key ability to transmit the guided luminescence without reabsorption losses, though, so as to complement high photovoltaic efficiency with dimensions compatible with real windows. The aesthetic factor is also of critical importance for the desirability of an emerging technology," Meinardi said.

Hunter McDaniel, formerly a Los Alamos CASP postdoctoral fellow and presently a quantum dot entrepreneur (UbiQD founder and president), added, "with a new class of low-cost, low-hazard quantum dots composed of CISeS, we have overcome some of the biggest roadblocks to commercial deployment of this technology."

"One of the remaining problems to tackle is reducing cost, but already this material is significantly less expensive to manufacture than alternative quantum dots used in previous LSC demonstrations," McDaniel said.

A key element of this work is a procedure comparable to the cell casting industrial method used for fabricating high optical quality polymer windows. It involves a new UNIMIB protocol for encapsulating quantum dots into a high-optical quality transparent polymer matrix. The polymer used in this study is a cross-linked polylaurylmethacrylate, which belongs to the family of acrylate polymers. Its long side-chains prevent agglomeration of the quantum dots and provide them with the "friendly" local environment, which is similar to that of the original colloidal suspension. This allows one to preserve light emission properties of the quantum dots upon encapsulation into the polymer.

Sergio Brovelli, the lead researcher on the Italian team, concluded: "Quantum dot solar window technology, of which we had demonstrated the feasibility just one year ago, now becomes a reality that can be transferred to the industry in the short to medium term, allowing us to convert not only rooftops, as we do now, but the whole body of urban buildings, including windows, into solar energy generators."

"This is especially important in densely populated urban area where the rooftop surfaces are too small for collecting all the energy required for the building operations," he said. He proposes that the team's estimations indicate that by replacing the passive glazing of a skyscraper such as the One World Trade Center in NYC (72,000 square meters divided into 12,000 windows) with our technology, it would be possible to generate the equivalent of the energy need of over 350 apartments.

"Add to these remarkable figures, the energy that would be saved by the reduced need for air conditioning thanks to the filtering effect by the LSC, which lowers the heating of indoor spaces by sunlight, and you have a potentially game-changing technology towards "net-zero" energy cities," Brovelli said.

More information: "Highly efficient large-area colourless luminescent solar concentrators using heavy-metal-free colloidal quantum dots." *Nature Nanotechnology* (2015) DOI: 10.1038/nnano.2015.178

Provided by Los Alamos National Laboratory

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Optimization of Barite Dissolvers by Organic Acids and pH Regulation

Combined

Average from 0 ratings

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DOI

http://dx.doi.org/10.2118/74667-MS

Export citation

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Abstract

The data in literature clearly proved that the polyamino carboxylic acids (PACAs) are promising barite dissolvers. So far, however, only the ethylene-diamin-tetraacetic acid (EDTA) and the diethylene-triamin-pentaacetic acid (DTPA) were studied and tested in detail. Therefore, an extensive research programme was launched to compare the potential of other barite dissolvers. The laboratory study were also extended to nitrilo-triacetic acid (NTA), diamino-cyclohexane-tetraacetic acid (DCTA), dioxaoctamethylene-tetraacetic acid (DOCTA), hydroxyethylene-diamin-triacetic acid (HEDTA) and triethylene-triamin-hexaacetic acid (TTHA).

Dissolving capacity of each compounds was determined as a function of concentration for barite and reservoir rocks. The absolute and relative dissolution selectivity and the matrix effect of formation rocks were precisely analyzed. Independent variable of the measurements was the pH and type of organic acids used as complex-forming promoters. In the batch type studies oxalic acid (OXA), malonic acid (MOA), maleic acid (MEA), succinic acid (SUA) and tartaric acid (TARA) were tested. It was concluded that the performance of well treatment methods (mitigation of formation damage, removal of barium sulfate scales, etc.) based on application of polyamino carboxylic acids can significantly be increased by adding sodium (potassium) hydroxide to the complex-forming agents and setting its concentration to optimal level. Application of organic acids jointly with polyamino carboxylic acids, however, could not be justified if the dissolver system had already been optimized by alkali addition. Thus, from practical point of view it has to be emphasized that optimization of barite dissolving methods by pH regulation is much more efficient and cost-effective than adding multi-functional organic.

Introduction

Barium sulfate as a scale forming compound was mentioned in literature a long time ago, but it is still in the focus of research even today. In 1967 Featherstone et al.[1] analyzed the different factors influencing the precipitation of $BaSO_4$ under formation conditions and pointed out that decreasing pressure and temperature, and especially the change of the solubility product may lead to scale formation, and hence, to modification of permeability. In the same year Weintritt and Cowan[2] published a paper in which the authors detailed the mechanism of sag formation, the role of adhesion forces in scale build-up and emphasized the special difficulties of adequate laboratory studies in case of barite. These two areas, production and drilling operations, are permanently concentrating on scale and sag removal and formation damage control. Importance of the topic is

well reflected by the fact that nearly 250 papers dealing with $BaSO_4$ scaling and barite sagging in formations and surface facilities have been published during the past decades. In the latter area the studies were accelerated when deep penetration and migration of colloidal barite fines in formations were recognized (e.g. Aliaga et al.[3]) and by realizing that the their effects could not be alleviated by acidization.

Behavior of barium sulfate in formation is sufficiently discussed in excellent text books[4-6] and papers[5-11]. In practice, a real break-through has happened when Shaughnessy and Kline[12] used EDTA successfully to improve producibility of oil wells in Alaska. Contribution of other authors, particularly Clemmit et al.[13] and Paul and Fieler[14] to chemistry of barium sulfate dissolution in the presence of EDTA and DTPA helped a lot to elucidate the mechanism of complex formation and indirectly, to extension of the field applications. Although the beneficial effect of mentioned chemicals became widely known and appreciated, the "barium sulfate" and "barite" problems worsened world-wide in off-shore production (e.g. Braden and McLelland[15]) which could not be efficiently cured by conventional tools, water jets, sophisticated chemical procedures, etc. Based on supporting new results of Vries and Arnoud[16] and Putnis et al.[17] further efforts had to be made to improve the basic technology. In the frame of these endeavors the study was extended to additional five complex-forming agents[18] and the effect of alkalis and organic acids as promoters were analyzed in detail. The present paper gives a brief summary of those laboratory experiments which were focused to the latter two questions.

File Size 236 KB**Number of Pages** 10