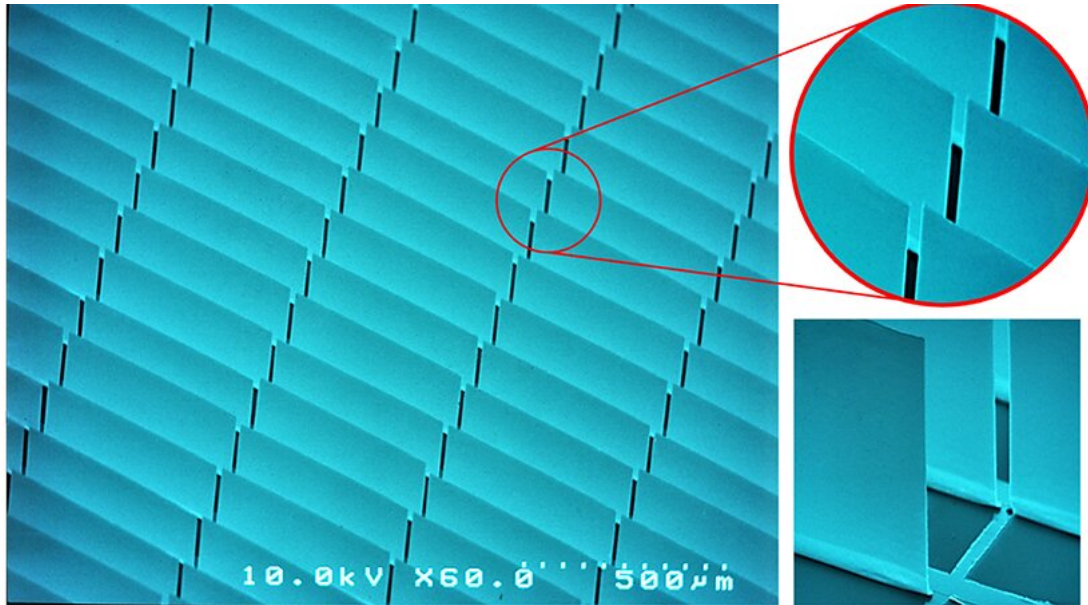


# Smart glass has a bright future

April 1 2021

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SEM micrograph of vertically standing, flat micromirror array with an inset of magnified area. Credit: Hillmer et al.

Buildings are responsible for 40 percent of primary energy consumption and 36 percent of total CO<sub>2</sub> emissions. And, as we know, CO<sub>2</sub> emissions trigger global warming, sea level rise, and profound changes in ocean ecosystems. Substituting the inefficient glazing areas of buildings with energy efficient smart glazing windows has great potential to decrease energy consumption for lighting and temperature control.

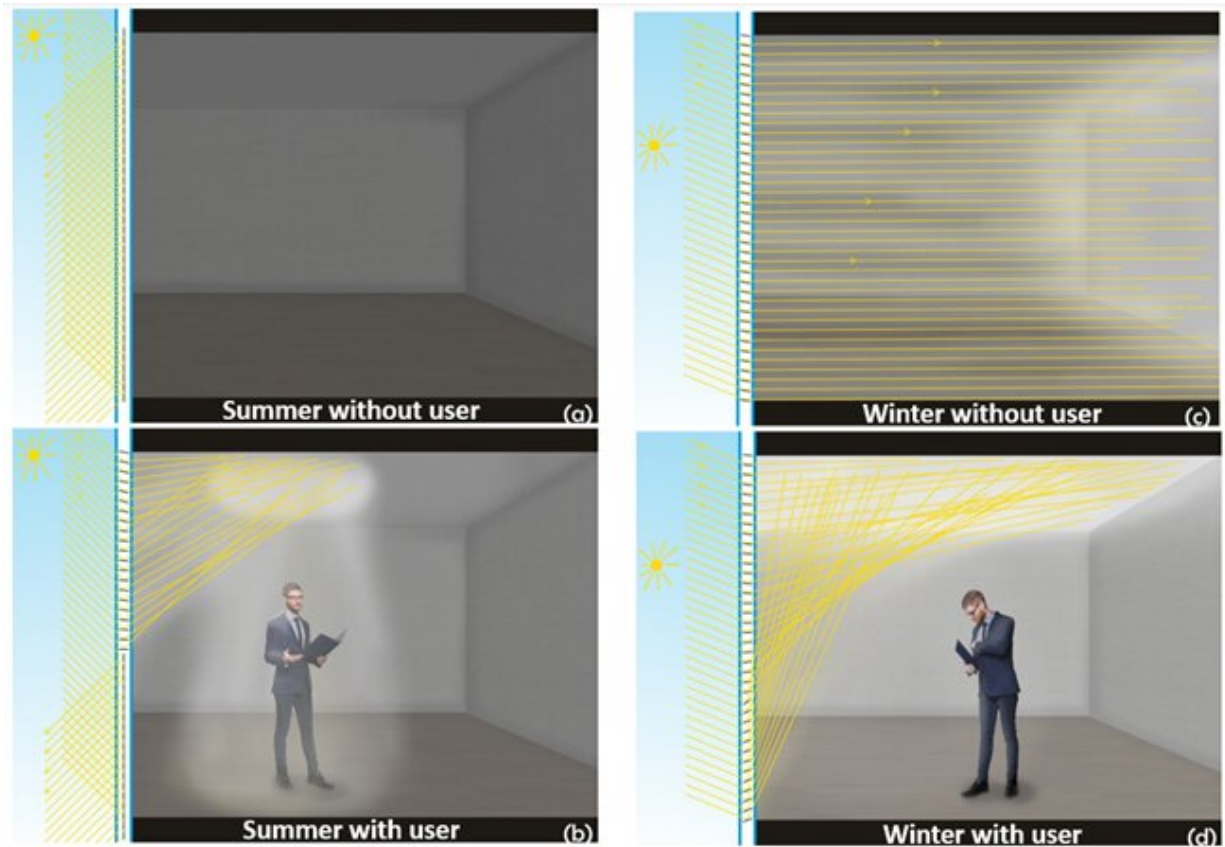
Harmut Hillmer et al. of the University of Kassel in Germany

demonstrate that potential in "MOEMS [micromirror](#) arrays in [smart windows](#) for daylight steering," a paper published recently in the inaugural issue of the *Journal of Optical Microsystems*.

"Our smart glazing is based on millions of micromirrors, invisible to the bare eye, and reflects incoming sunlight according to user actions, sun positions, daytime, and seasons, providing a personalized light steering inside the building," Hillmer said.

The micromirror array is invulnerable to wind, window cleaning, or any weather conditions because it is located in the space between the windowpanes filled with noble gas such as argon or krypton. The glazing provides free solar heat in winter and overheating prevention in summer, and it enables healthy natural daylight, huge [energy](#) savings (up to 35 percent), massive CO<sub>2</sub> reduction (up to 30 percent), and a reduction of 10 percent steel and concrete in high-rise buildings.

Apart from the energy problem, [artificial lighting](#) also has consequences for health and well-being. Various studies have linked artificial lighting to lack of concentration, high susceptibility to illness, disturbed biorhythms, and sleeplessness. Smart glass can reduce reliance on artificial lighting by optimizing natural daylight in a room.



(a) If no user is present in summer all mirrors switch vertically, keeping solar heat outside. This saves huge energy by minimizing heat transfer. (b) Once user presence is detected by sensors in summer, upper mirrors open and reflect daylight to the ceiling area. The room stays cool where no user is standing, saving energy on climatization. Parts of the room far away from the window can be efficiently illuminated by daylight, saving energy on artificial light. (c) If no user is present in winter, all mirrors open and harvest energy by reflecting solar radiation onto a wall, acting as a radiation heater. This saves energy for heating. (d) Once user presence is detected in winter, all the mirrors will redirect the complete solar radiation to the ceiling to minimize glare. Now, the ceiling acts as a radiation heater, saving heating energy. Credit: Hillmer et al.

Current state-of-the-art smart glazings are currently optimized either for winter or for summer-and not able to ensure energy-saving performance

year-round. There has been a need for a smart and automatic technology that can react to local climate (daytime, season), uses available sunlight, regulates light and temperature, and saves substantial energy.

The researchers' MEMS micromirror arrays are integrated inside insulation glazing and are operated by an electronic control system. The orientation of mirrors is controlled by the voltage between respective electrodes. Motion sensors in the room detect the number, position, and movement of users in the room.

The results include much higher actuation speed in the sub-ms range, 40-times lower power consumption than electrochromic or liquid crystal concepts, reflection instead of absorption, and color neutrality. Rapid aging tests of the micromirror structure were performed to study reliability and revealed sustainability, robustness, and long lifetimes of the micromirror arrays.

And with positive results like that, the benefits of this smart glass are crystal clear.

**More information:** Harmut H. Hillmer et al, MOEMS micromirror arrays in smart windows for daylight steering, *Journal of Optical Microsystems* (2021). [DOI: 10.1117/1.JOM.1.1.014502](https://doi.org/10.1117/1.JOM.1.1.014502)

Provided by SPIE

Citation: Smart glass has a bright future (2021, April 1) retrieved 4 May 2024 from <https://techxplore.com/news/2021-04-smart-glass-bright-future.html>

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