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Interior colour rendering of daylight transmitted through a suspended particle device switchable glazing

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ABSTRACT

The colour rendering index (CRI) and correlated colour temperature (CCT) of daylight change upon transmission through a variable transmittance suspended particle device (SPD) switchable glazing. The luminous transmittance of SPD glazing was found to vary from 0.02 to 0.55 in opaque and transparent state respectively. Below 0.14 transmittance, the CRI for a particular SPD glazing was less than 80. No strong correlation was found between CCT and CRI. The CRI of SPD glazing in a transparent state was similar to double panes glazing for SPD glazing transmittance greater than 0.24.

1. Introduction

The glazed features of a building provide views to the exterior, allow solar heat gain, incur heat losses, provide daylight, can cause glare and are often a conduit for ventilation air. Glazed features include windows roof lights, conservatories and atria. Such glazed elements particularly in non-domestic buildings are frequently an important realization of a design intent to create internal spaces that are visually connected internally with one another and externally to the immediate surroundings [1]. However, in many climates, a certain times incident solar radiation can overheat highly glazed buildings. This can be mitigated by ventilations, storage of heat in the buildings by the appropriate inclusion of thermal mass and design that exploits the variations of glazing transmission with the angular incidence of solar radiation in the specified orientation and inclination of glazing [2]. Overheating may also be inhibited by range of internal and external shading device, or by the use of adaptive variable transmittance glazings. The latter have the potential to minimize the building energy demand by reducing cooling, heating and lighting loads whilst providing daylighting via the various different combinations of attributes illustrated in Fig. 1.ed re

Solar heat gain control glazings are mainly switchable while low heat loss control glazings have constant transparency [3–10]. Both types have potential to allow daylight. Fig. 1 shows the details of different types of glazing.

Suspended particle device (SPD) glazing is a form of switchable adaptive glazing in which a plastic film sandwiched between two glass panes contains suspended dihydrocinchonidine bisulfite polyiodide or heraphathite SPD particles [11–13]. The particles may be needle-shaped, rod-shaped, or lath-shaped. In the presence of power supply, the particles are orientated perpendicular to the substrate so that light transmit and without power supplies the particles are oriented randomly due to Brownian movement. Illustration of the operation of an SPD glazing is shown in Fig. 2.

SPD switchable adaptive glazing

- has electrically powered ease of control [14];
- can be connected directly with AC mains power supply without any conversion system (An electrochromic glazing requires an AC to DC inverter to connect with mains) [14];
- can control solar heat gain due to its variable transparency [15];
- facilitates switchable single or double glazing systems [16,17];
- controls glare and facilitating comfortable daylighting [18].

Daylight is the luminance associated with that part of the solar irradiance with a spectral power distribution in the visible range of 380–780 nm. The spectral power distribution of natural daylight depends on time of day, season, latitude, weather, and air bound dust and pollutants. Visual comfort in an internal glazed space during the day is influenced by the quality and quantity of transmitted daylight into that space. The spectral transmission properties of a glazing, can be characterized by a correlated colour temperature (CCT) and colour rendering index (CRI).

CRI and CCT are used to characterize the illumination quality of white light [19,20]. A CCT needs to be equivalent to that of a blackbody source at temperatures between 3000 and 7500 K [21,22]. The CCT indicates of whether the light is bluish-white, neutral, or reddish white.

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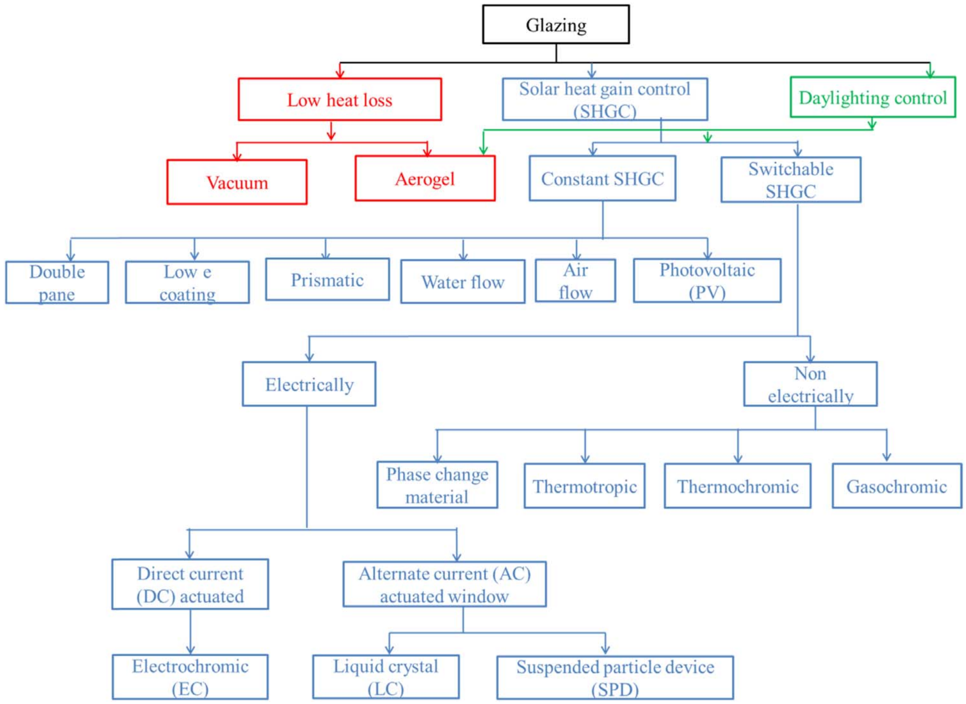

Fig. 1. Indicative taxonomy of selective glazing types.

The CRI includes spectrally dependent characteristics with CRI values of 95 or higher considered acceptable. A CRI close to 100 indicates an excellent visual quality [23]. Light colour is an influential factor on indoor comfort.

Yellowish and reddish with warm CCT [24,25] have been alleged to produce beneficial psychological effects [26–29] however, the empirical data supporting this is weak [30]. Quantity of light (i.e. illuminance) and the quality of light (i.e. CCT) are used to assess the perceived quality of a lit environment [19]. CRI and CCT have been evaluated for semitransparent PV [31], electrochromic glazing [32] gasochromic glazing and luminescent solar concentrator glazing [33]. For tinted glazings under average daylight (D65) a CRI of 95 and 87 were reported for brown and green glazings, respectively [22].

The spectrum of transmitted daylight changes as an SPD glazing switches from an opaque to transparent state under power supply. Light spectral composition significantly affects the perceived colour and brightness of illuminated objects. CRI and CCT characterization of SPD glazing is required as these parameters assess human response to colours.

In this work luminous transmittance, CCT and CRI has been evaluated for the incoming daylight through switchable SPD glazing. CCT and CRI of SPD glazing were compared with those of double paned glazing with air filled and evacuated glazing.

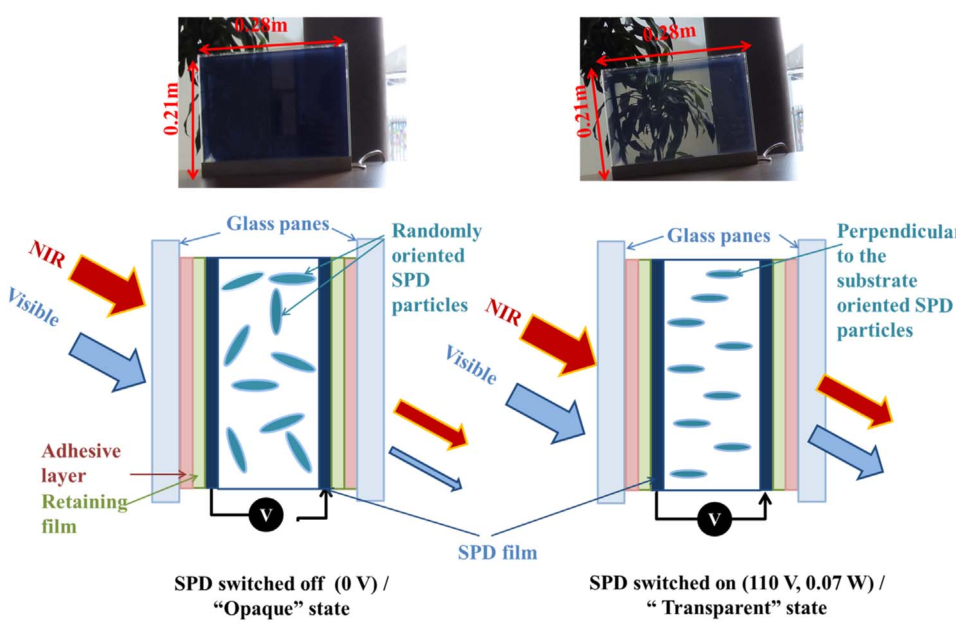

Fig. 2. Viewing through a particular SPD glazing in its opaque and transparent states.