Developing Circadian Health-Supportive Architectural Glazing Films from Natural and Bio-derived Materials

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Abstract: The critical relationship between natural light and indoor visual quality has been a foundational aspect of architectural and environmental design for many years. The late afternoon's red-enriched daylight is identified as one of the significant triggers of the "sundowning syndrome" in dementia care. Sundowning is marked by the emergence or worsening of neuropsychiatric symptoms. Architectural glazing, as the primary mediator of daylight transmission from outdoors, significantly influences both conventional (photopic) visual quality and emerging (melanopic) circadian health. The objective of this research is to develop a spectrally-selective and angular-dependent optical system, tailored specifically for lower incident angles of red-enriched solar light. To develop such films, this project seeks to combine the consistent porous texture derived from natural pine wood and the subsequent coating of specific light absorption characteristics of phycocyanin (a naturally occurring pigment). The natural woods are firstly processed by a UV-light-assisted fabrication method to completely remove the light-absorbing lignin from the cell walls, yielding a transparent substrate. Subsequently, a prepared phycocyanin solution, a pigment known for its strong red light absorption, is infiltrated for conformal coating onto the porous framework in the substrate. The expected outcome is the film that can enhance circadian health by modulating transmitted light while maintaining conventional daylighting benefits, along with potential electrical lighting energy reduction. This project innovates by utilizing natural materials' structures and optical features, advanced fabrication methods, and integration of photometry and radiometry principles to create a new approach to support circadian health.