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Photothermal effect on Fe_3O_4 nanoparticles irradiated by white-light for energy-efficient window applications

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A significant energy loss results from the poor thermal insulations of the commercial and public buildings, especially from windows. The current technology for efficient windows relies upon the double-pane insulated glass unit with an insulating gas in between. The photothermal effect can collect solar energy for reducing heat loss without relying on insulating materials. The insulation efficiency is quantified through the U-factor, defined as the ratio of the heat flux (H) per unit area through the pane to the difference (ΔT) between the window interior surface and exterior temperatures. Upon solar irradiation, single-panes can self-heat via the photothermal effect from the nanoparticle coatings. This can effectively reduce ΔT for enhanced thermal insulation. In this study, the photothermal effect on Fe_3O_4 nanoparticles stimulated by solar light was investigated for nanoparticles in solutions and as thin films for energy-efficient windows. The Fe_3O_4 nanoparticles were surface-functionalized with different polymers to modulate colloidal stability and for the investigation of the photothermal effect. The photothermal heating efficiencies of Fe_3O_4 with different surface coatings were found to be much greater under the white-light irradiation than near infrared (NIR) in both aqueous suspension and as thin films. The mechanism for the photothermal effect of Fe_3O_4 was identified in terms of its band structure. Both Urbach energy and band gap were obtained based on absorption spectra of various Fe_3O_4 nanoparticles. The Urbach tail was found consistent with nanoparticle surface defect structures, while the band gap (~3.1 eV) corresponded to the electronic transitions in the octahedral site of Fe_3O_4. We also discuss the absorption based photonic physics responsible for the much-enhanced photothermal heating by white-light as compared with NIR. Based on the photothermal heating, the U-factors were obtained with the nanoparticle coatings that show promise in producing energy efficient windows.

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Wind field distribution in Georgia

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In Georgia due to complex orographic conditions and influence of the black Sea there exist most of Earths climatic types, from marine wet subtropical climate in west Georgia and steppe continental climate in east Georgia up to eternal snow and glaciers in high mountain zone of Great Caucasus and also approximately 40% of observed landscapes. The Georgian relief may be characterized by three sharply expressed orographic elements: Caucasus in north, in south - Georgian south upland and lowland or intermountain depression located between those two risings. This one begins from The Black Sea shore namely Kolkheti Lowland triangle and spreads up to eastern Georgia like a narrow strip. Between those two uplands small scaled orographic elements can be allocated. Such complicated relief has definite influence on air masses motion in atmosphere lower layers. Mainly west and eastern atmospheric processes prevailed over Georgian territory. Current geodynamics and orographic properties of Georgia play an important role in formation of weather various patterns. Such complex relief conditions the formation and evolution of various scaled circulation systems and heterogeneous spatial distribution of meteorological elements. This is verified by the fact, that such important parameter as wind annual distribution has diverse type with sharply expressed spatial inhomogeneities. The wind is one of most important meteorological element used both in science and energetic industry. However its origin and nature is not well understood yet. Wind direction and value in atmosphere surface layer is depending on local geographic conditions. The meteorological observation data, Earth Observing System Satellite data are used to conduct statistical analysis in order to identify wind parameters. For this reason mesoscale troposphere flows mathematical model for local area has been developed. GIS maps were constructed that show local areas for wind power application.

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