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Elaboration of thermochromic LaCoO3 thin films using semi-industrial sputtering machine

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In the past, we demonstrated the feasibility of a thermochromic solar collector based on VO_2 and commercialized it under the name ThermProtect®. The present work concerns the elaboration and the optimization of a new generation of solar collectors based on large $LaCoO_3$ coatings. Thermochromism is the aptitude of some materials to reversibly change their electrical, optical and magnetic properties versus temperature due to structural modifications. Such change occurs at a specific temperature called metal-insulator transition temperature (T_{MI}) and thus, thermochromic materials are IR transparent (insulator) below T_{MI} and IR reflective (metal) above. Perovskite-type oxide $LaCoO_3$ exhibits complex and temperature dependent behavior. It is known, that $LaCoO_3$ undergoes successive spin-state transitions as a function of temperature resulting in thermochromic effect and unsharpened transition from these two states accompanied by a drastic change in emissivity which makes it an excellent candidate for passive thermal regulation applications. However, due to the structural and chemical complexity of such system, the synthesis of this material at semi-industrial scale is challenging. For this work, we investigated deposition and annealing conditions and performed structural and optical characterization of deposited coatings.
The films were synthesized on Al substrates by magnetron co-sputtering of two pure metallic targets (99.95%) using an in-line semi-industrial coating machine especially designed for depositing on A4-size substrates. The films were deposited in elemental (ESM) and compound (CSM) sputtering modes. To obtain the perovskite structure, annealing in air of as-deposited films was performed between 500 and 580°C. The SEM topographical analysis shows that dense and homogeneous films were obtained. The annealing conditions leading to crystalline perovskite structures were confirmed using XRD analysis. The evaluation of IR emissivity variations by infrared camera clearly shows a strong increase in emissivity for temperatures higher than 200°C and the emissivity variation (Δε) reaches 50%.

Keywords
thermochromic perovskite coatings