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Perovskite: From zero to hero

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Perovskite solar cells based on organometal halides represent an emerging photovoltaic technology due to its low cost and high-efficiency. Perovskite solar cells stem from dye-sensitized solar cells. However, the liquid-based perovskite solar cell receives little attention because of its stability issues including instant dissolution of the perovskite in a liquid electrolyte. Unlike the liquid-based perovskite, the efficiency of perovskite-based solar cells has increased rapidly from 3.8% in 2009 to 19.3% in 2014 by using the all-solid-state thin-film architecture and engineering cell structures with mixed-halide perovskites. The emergence of perovskite solar cells revolutionized the field not only because of their rapidly increased efficiency but also flexibility in material growth and architecture. The superior performance of the perovskite solar cells suggested that perovskite materials possess intrinsically unique properties. Since PCE values over 20% are realistically anticipated with the use of cheap organometal halide perovskite materials, perovskite solar cells are a promising photovoltaic technology. In this talk, the opto-electronic properties of perovskite materials and recent progresses in perovskite solar cells will be discussed. We also discuss some current challenges of using perovskites in solar cells along with possible theoretical solutions.

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Open pipe and nozzle external flows in drifted wind turbines

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From the classical fluid mechanics, it is realized that nozzle devices will accelerate flows in internal flows. For application of such devices in innovative wind turbines such as shrouded or wind catcher ones, it is however required to study open nozzle or diffuser devices in external flows. In this work, some examples of short open pipes and nozzles in horizontal and vertical flow directions are studied using analytical and numerical methods. The analytical method is simply based on the application of Bernoulli equation with considering pressure losses within the devices. The numerical solution was obtained by solving the modelled RANS (Reynolds Average Navier-Stokes) equations in two dimensional flows. The results indicate that the wind speed through the horizontal open nozzles and pipes are not increased by the area ratio and just retarded by the effects of pressure losses. In other words, no appreciable increase of downstream wind velocity is obtained compared with the freestream wind by using shrouded nozzle envelope for a horizontal axis wind turbine. For the vertical open nozzle and pipe flows, however, the effects of natural drift due to the height is more pronounced compared with ineffective area ratio of nozzle devices. This merely shows that the added gravity head will affect downstream flows and not the nozzle area ratio. It is concluded that the vertical wind collectors or wind concentrators in forms of nozzles or pipes designs such as INVELOX turbine concept are useful in utilizing gravity head for increasing low wind speeds through their natural drift mechanism. But the effects of natural drift are reduced to retard flow speed in high wind speeds. Hence, multiple nozzles with appropriate tower height may be usedto accelerate wind speed in similar designs.

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