MAE Seminar Series

Engineered Bio-inspired Micro-surface on a Wind Turbine Blade: The Case for Renewable Energy on the Water Crisis

Tuesday,
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3:45 pm
Davis 101

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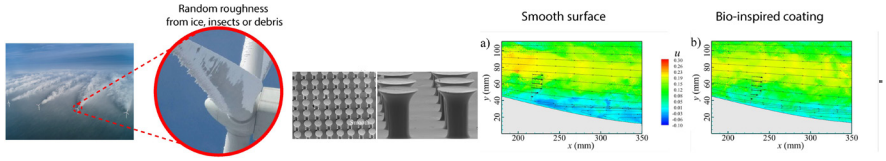
ABSTRACT

As the United States leaves the Paris Agreement, and with the current interest to push forward more fossil fuel energy sources, the need to articulate the impact of expanding these energy sources on precious water reserves becomes imperative. In this seminar we will demonstrate that nearly 50 percent of US water is employed for cooling of power plants in the United States. Thus, wind energy can indeed be a major solution in our water crisis.
Moreover, surface roughness can result from mosquitoes and other debris that are impacted on the surface of wind turbine blades, creating a layer of random roughness. This is known to negatively impact the performance of wind turbines, increasing form drag by moving the separation point toward the leading edge, thus increasing the external loads that negatively affect the drive-train and energy production. In this seminar, we will discuss how a bio-inspired micro-scale surface of a mushroom type that modulates the flow dynamics of a wind turbine airfoil. Our experimental results from an index-matched facility provide evidence that this bio-inspired surface does not produce additional turbulence as normally encountered on rough surfaces. By employing this micro-scale surface on an airfoil (see figure below), we showed that the separation point moved toward the trailing edge. Although this bio-inspired surface modulates the flow evolution, the behavior of the flow is quite opposite to the typical surface roughness. The mechanism by which the flow dynamics changes and reduces separation is due to injection and blowing along the surfaces, producing regions of high speed along the surface. Consequently, the bio-inspired surface produces an effective slip velocity near the wall region contrary to surface roughness. Besides wind energy applications, this unique surface offers benefits of drag reduction for hydrodynamic bodies, airplanes, trans-continental pipes and cars. Furthermore, there is evidence that similar surfaces possess self-cleaning properties, and the micro-pillar coating works under wetted conditions.



BIO SKETCH

Prior to joining Purdue University as the Kenninger Chair Professor of Renewable Energy & Power Systems, Luciano was the inaugural Center Director of the National Wind Resource Center and the Don-Kay-Clay Cash Distinguished Engineering Chair in Wind Energy at Texas Tech University. For many years he was Professor at Rensselaer Polytechnic Institute in the Mechanical & Aerospace Department. His areas of research interest include: turbulence, renewable energy and bioengineering. He has published over 100 publications, edited several books on renewable energy and co-authored several patents (e.g., energy, health care, etc.). Some of his awards include: Fellow ASME, the NASA Faculty Fellowship, the Martin Luther King Faculty Award, the Robert T. Knapp Award Best Paper Award from the ASME, the Best Paper Award from the Journal of Renewable Energy, the Best Paper Award from IEEE, and the Rensselaer Faculty Award (twice). He gave several keynotes lectures, plenary lecture, and distinguished lectures on wind energy. Currently, he serves as Associate Editor of Wind Engineering & Science, and serves in various scientific committees on renewable energy in Europe. He is passionate about inclusiveness and mentoring students and young faculty, and founded and organized two summer research institutes on renewable energy & medicine, which included students, faculty and K-12 teachers. For his contributions and impacts on inclusiveness he received in 2016 the McDonald Mentoring Award from ASME, and was nominated for a Presidential Award given by the President of the USA. He received his BS and PhD degrees from UB under the supervision of William K. George in 1990, and 1996 respectively.

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