Sino-Danish Scientific and Technological Cooperation Project

3D VIRTUAL TESTING OF COMPOSITES FOR WIND ENERGY APPLICATIONS: COMPUTATIONAL MESOMECHANICS APPROACH

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The efficiency and practical usability of wind energy technology depend on the reliability and lifetime of wind turbines. The repair and maintenance of wind turbines are typically quite expensive and labor consuming. However, failure of wind turbine parts, notably, wind blades, does occur sometimes, and it leads to huge expenses and has negative effect on the public image of wind energy technology. But how can one improve the lifetime of wind blades?

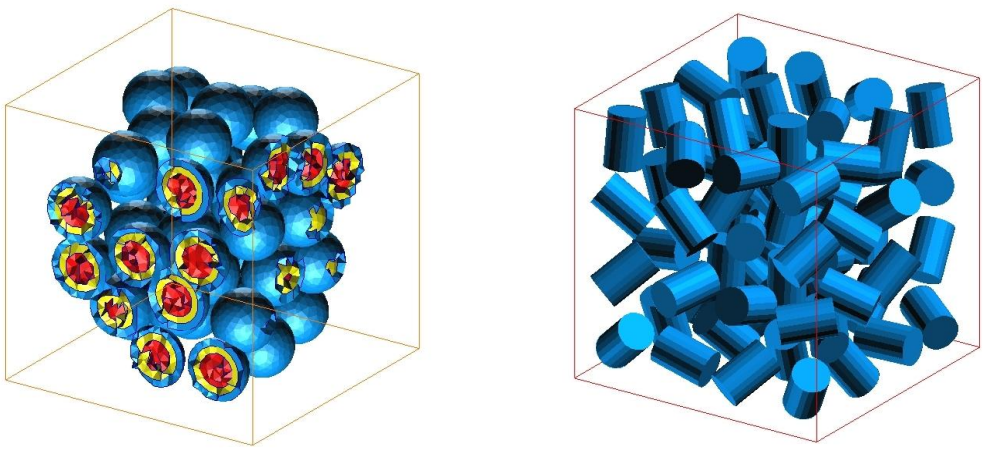

Figure 1. Multiparticle models with different shaped filler (Some interface and particle elements

are removed to see the effective interface structure)

It is known that adding small amount of nanoparticles reinforcement can lead to the drastic, qualitative improvement of the strength and stiffness of polymers While the nanoparticle reinforced materials have been rather expensive a few years ago, now their prices tend to reduce, and their broad use can be expected in near future. So, the question arises: can the composites with nanoparticle reinforced components become the future wind energy materials? In this project, we seek to analyze the applicability and usability of hierarchical composites, with nanoengineered polymer matrix, to be used as the materials for wind blades.

In order to explore the effect of the nanoreinforcement on the mechanical properties and strength of polymer matrix, a series of computational models of nanocomposites has been developed. Using the effective interface model, we develop the method of automatic generation of multiparticle unit cells with spherical, plate-like and cylindrical particles surrounded by the effective interface layers. The generalized effective interface model, with two layers of different stiffnesses and the option of overlapping layers is included into the model

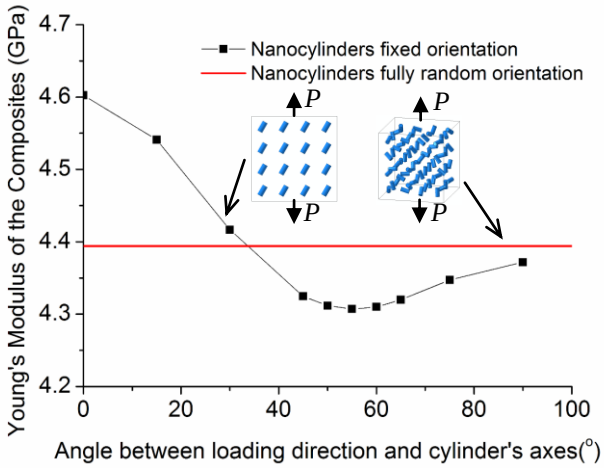

Figure 2. Comparison between the cases of random orientation of nanoparticles and the cases of fixed orientation of nanoparticles

References:

1. L. Mishnaevsky Jr, *Computational Mesomechanics of Composites*, John Wiley and Sons, 2007, 290 pp.
2. H.W. Wang , H.W. Zhou, R.D. Peng, Leon Mishnaevsky Jr., *Nanoreinforced polymer composites: 3D FEM modeling with effective interface concept* (submitted)
3. H.W. Zhou, L. Mishnaevsky Jr, P. Brøndsted, J. Tan, L. Gui, SEM in situ laboratory investigations on damage growth in GFRP composite under three-point bending tests, *Chinese Science Bulletin*, 2010 Vol.55 No.12: 1199−1208 (Cover Story)
4. H. W. Wang, H.W. Zhou, L. Mishnaevsky Jr., P. Brøndsted, L.N. Wang, Single fibre and multifibre unit cell analysis of strength and cracking of unidirectional composites, *Computational Materials Science*, Vol. 46, No. 4, 2009, pp. 810-820