ME Seminar

Polymer brush-based tribology

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ABSTRACT

Polymer chains with one of their ends grafted on a surface, stretch out in a good solvent to take a brush-like formation when the grafting density, $\rho_g > 1/\left(\pi R_g^2\right)$, where R_g is the radius of gyration of a chain in a good solvent. The equilibrium height of such a polymer brush is larger than the unperturbed size (R_g) of the corresponding polymer chain in a bulk solution. Polymer brushes find applications in the fields of tribology, rheology, biology and colloid-stabilization. Polymer brush based tribology is a recent attempt to mimic glycoproteins based lubrication found in nature. Higher coefficients of friction are observed due to asperity-asperity contact when hard surfaces are brought in contact and sheared against each-other. In contrast, when polymer-brush bearing surfaces are brought in contact with each-other and sheared in the presence of a good-solvent, much lower coefficients of friction are observed. Due to entropic reasons opposing polymer brushes avoid inter-digitation even under high compression enabling development of a thin fluid film between the brushes. Such a formation helps polymer brushes to support relatively high applied normal load while the thin fluid film in-between helps in reducing the friction. Tribological behavior of polymer brushes can be tuned by changing the grafting-density (ρ_g), chain-length (L_c), chain-stiffness (K_b), solvent-quality and cross-linking of chains. Possibility of designing lubricant with specific tribological properties make polymer-brushes an interesting topic of research. In this chapter we will go through the effects of different polymer-brush architectures on the tribological behavior of polymer brushes.

References

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ABOUT THE SPEAKER

Dr. Singh is currently working as an Assistant Professor at the Department of Mechanical Engineering, IIT Kanpur where he joined in September 2019. He has an interdisciplinary background with education in Mechanical and Materials Engineering and research experience in both computer simulations and experiments. The principal areas of his research are tribology and rheology - mostly with polymers. Before joining IIT Kanpur, Dr. Singh worked as postdoctoral researcher in Polymer Theory group at the Max Planck Institute for Polymer Research Mainz. He has done PhD in polymer tribology from the Department of Materials, ETH Zurich, Switzerland. He finished his Master of Engineering (ME) degree from the Materials Engineering Department of Indian Institute of Science, Bangalore. He studied for a Bachelor of Engineering (BE) at Mechanical Engineering Department of Indian Institute of Engineering, Science and Technology, Shibpur (formerly BE College or BESU Shibpur), West Bengal, India.

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