Synopsis

Surface texture has been successfully used in many fields to improve the performance of surfaces, in applications like drag reduction, control of wettability, and enhancement of heat transfer. In tribology, surface texture is considered to be one of the promising methods to control friction, wear, and lubrication. The effect of texture on lubricated contacts is well documented. On dry contact, few studies exist on texturing, and in most of these studies, either one or both contacting surfaces undergo permanent deformation. In this work, we study the effect of microscale and nanoscale textures on friction under elastic dry reciprocating contacts.

Different types of surface textures are generated in micron scales and in nanometer scales. In microscale, two types of textures, micropillars and microdimples are generated on stainless steel surfaces using wire electrical discharge machining (EDM) and laser drilling respectively. For nanoscale surface textures, ordered hexagonal arrays of pores formed by anodisation of aluminium, are used. An ordered nanocomposite surface formed by filling the pores with copper is also used. To span a wide range contact area, two high stiffness reciprocating tribometers are developed. To ensure elastic contact, reciprocating experiments are carried out on a flat-on-flat configuration for microscale texture surface and on a ball-on-flat configuration for nanoscale texture surface. The tangential friction force is measured using a piezoelectric force sensor and a specially developed load cell.

It is found that the measured coefficient of friction (COF) is independent of the number of texture elements in contact. The geometry and the scale of the texture also did not have any measurable effect on the friction. Only the work done per cycle, as measured from tangential force - displacement loop varies with the texture geometry. From micropillar experiments, the work done per cycle is found to depend on the elastic

deformation of the micropillars in contact. To generalize the experimental findings, multiple texture contact was modeled as a lumped system with Coulomb friction. From quasi-static analysis and dynamic simulations, it is established that the COF in a multiple texture contact is same as the COF specified for individual texture element. The work done per cycle varies with the stiffness of the texture elements and normal load and is found to be dependent on the elastic stored energy at the end of the stroke.