Numerical analysis of the consequences of roughness modifications in 3D hydrodynamic contacts

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Abstract

A theoretical study is presented to evaluate the influence of the structure size of laser textured surfaces on the tribological performance of reciprocating automotive components. A topographic image representing a laser textured liner surface is progressively filtered, using morphological alternating sequential filters of increasing size, in order to transform the roughness of the initial surface. A numerical tool simulating the hydrodynamic contact between piston rings and liner is then used to compare the performance of the textures issued from filtering process. The results of this analysis can constitute key data for the definition of new and efficient textured surfaces with this type of application.

Keywords: hydrodynamic contact, friction, surface roughness, surface texturing, morphological filtering, numerical tribometer.

Nomenclature

$\mathcal{P}$	The smooth plate simulating the piston ring
$\mathcal{R}$	The rough surface simulating the liner
Ω	The computation domain confined by $\mathcal{P}$ and $\mathcal{R}$
l_1	Computation domain length on x_1 axis (m)
l_2	Computation domain length on x_2 axis (m)
l_3	Computation domain length on x_3 axis (m)
$\vec{v}_p$	Velocity of $\mathcal{P}$ (m/s)
$\vec{v}$	Local fluid velocity (m/s)
p	Local fluid pressure (Pa)
p_1	Downstream pressure (Pa)
p_2	Upstream pressure (Pa)
ρ	Fluid density (kg/m^3)