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Enhanced lubrication effect of gallium-based liquid metal with laser textured surface

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Abstract: Gallium-based liquid metals which hold high thermal stability and conductivity are promising lubricant candidates for harsh environment. In this study, the lubrication behaviours of $Ga_{76}In_{24}$ (LM) were investigated for steel/steel contact under different contact stresses and sliding speeds. Surface texturing technique was proposed to enhance the lubrication behaviours of LM. Textured surfaces with different area ratios were fabricated by nanosecond laser texturing and characterized by scanning electron microscope and laser scanning confocal microscope. Tribological results demonstrate that applied load as well as sliding frequency can influence the LM's lubrication behaviours and that textured surface can improve LM's anti-friction and anti-wear abilities. Moreover, the relative lubrication mechanisms for untextured and textured surfaces are discussed.

Key words: liquid metal, lubricant, textured surface, anti-friction and anti-wear.

1. Introduction

The development of aviation and nuclear industries sets extremely high demands on the lubrication conditions. Unreliability problem due to insufficient lubrication is still faced by some aerial mechanical moving components including rotor bearings, gears and seals which operate under high temperature and load[1]. Solid lubrication is a traditional method adopted in aviation and nuclear industries[2-5], and various self-lubricating coatings or films are utilized to reduce friction and wear, but the film's breakage and desquamation from substrate limit their applications on aviation and nuclear industries[6-9]. Compared with solid lubrication, liquid lubrication holds many advantages, such as good fluidity, low friction and wear, and recyclability. However, most traditional liquid lubricants are made of organic hydrocarbon compounds which have poor thermal stability and will discompose at harsh environments.

Gallium based liquid metals are emerging as a novel liquid lubricant for aviation and nuclear industries, due to their splendid properties such as high temperature stability, high thermal conductivity, broad liquid