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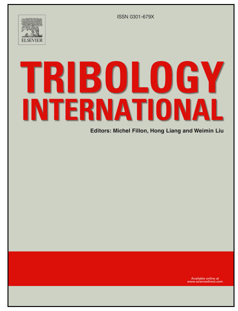

The synthesis of magnesium silicate hydroxide with different morphologies and the comparison of their tribological properties

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Title: The synthesis of magnesium silicate hydroxide with different morphologies and the comparison of their tribological properties

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Abstract: The tribological properties of magnesium silicate hydroxide (MSH) synthesized at different hydrothermal conditions as lubricant additives were investigated. The morphologies and structures of synthetic MSH were characterized by SEM, TEM, XRD and XRF. The tribological properties of MSH were evaluated using a four-ball friction and wear tester. It is found that different morphologies and structures of MSH are formed through different mechanisms depending on the temperature and reaction-time. Using synthetic MSH as an additive forms a tribofilm on the sliding surface and significantly improve the tribological properties of the oil. MSH with a tubular crystal structure has the best anti-wear property because it is more likely to deposit, adsorb and spread on the friction surface, and thus forms a denser tribofilm.

Key words: hydrothermal conditions; synthetic magnesium silicate hydroxide; additive; friction and wear

1. Introduction

Magnesium silicate hydroxide (MSH) with an ideal formula of $Mg_3Si_2O_5(OH)_4$ is the main component of serpentine-group minerals. Serpentines are the general designation of hydroxyl silicates and ubiquitous in many geological systems. In response to the geometrical misfits between Si-O tetrahedral sites and Mg-O/OH octahedral sites (the basic units of MSH) and substitutions for Si and/or Mg, serpentines display different structural and morphological types such as cylindrical chrysotile, layered antigorite, and planar lizardite. Among these, chrysotile minerals are widely applied in the field of refractories, and electrical insulations due to its distinctive fibrous structure [1] and antigorite minerals are widely investigated by scholars for its excellent tribological properties [2-7]. Zhang et al. [2] added serpentine and some catalysts in the crankcase oil for a friction and wear test of 150,000 Km and found a layer with super hardness and super smoothness formed on the rubbing surface of the cylinder which mainly contained Fe and O elements. Yu et al. [3] used formulation out of natural serpentine minerals as the oil additive and results showed a diamond-like carbon (DLC) film formed on rubbing partners. Yu et al. [4-7] studied the tribological properties of surface-modified serpentine particles as oil additives. Results indicate that a nanocrystalline tribofilm with distinct mechanical properties and phases of SiO_2 and Al_2O_3 embedded devotes to the excellent tribological performance. The main viewpoints for improving the friction-reduction and anti-wear including the following two points: (a) mechanical and physical effects, serpentine particles adhere and spread on the worn surface; (b) tribochemical reactions, such as tribofilms formed on the worn surface.

In recent years, with the extensive applications of nanomaterials in various fields, there have been many investigations on the tribological properties of lubricants with nanoparticles added [8-13]. However, nano-sized natural serpentine powders are scarcely prepared by high-energy mechanical ball-milling which is not well suited for applications as lubricant additives, and clarification of its tribological mechanisms due to varying morphology and difficulties controlling composition. Synthesizing MSH nanoparticles intended to solve this problem as well as to open path for further performance optimization. Actually, since the discovery of one-dimensional nanomaterial, scholars have been attempting to synthesize stoichiometric $Mg_3Si_2O_5(OH)_4$ nanotubes because of its special