

TRIBOCERAMIC COATING COMPOSITION DEVELOPMENT BY SOL-GEL METHOD

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Friction, wear and lubrication between materials in contact are of fundamental importance in many pure and applied sciences. Owing to the development of experimental and computer-simulation techniques for studying these phenomena at the atomic scale, an understanding is beginning to emerge of the molecular mechanisms of tribology in thin films and at surfaces [1]. Fundamental molecular issues in lubrication chemistry were reviewed under categories of solution chemistry, contact chemistry and tribochemistry. By introducing the Density Functional Theory (DFT)-derived chemical reactivity parameters (chemical potential, electronegativity, hardness, softness and Fukui function) and related electronic structural principles (electronegativity equalization principle, hard-soft acid-base principle, and maximum hardness principle), their relevancy to lubrication chemistry was explored. It was suggested that DFT, theoretical, conceptual and computational, represents a useful enabling tool to understand lubrication chemistry issues prior to experimentation and the approach may form a key step in the rational design of lubrication chemistry via computational methods [2].

The tribological aspects determined by the size are widely spread and most comprehensive work up to date reviews materials in the field of micro and nanotribology such as MoS₂, carbon nanotubes, liquid crystals and other lubricants [3]. Much less is published about hard thin films for machine elements which demand a hard resistant surface and a tough core. One of the promising technologies to develop such coatings is the combination of plasma nitriding of the steel substrate followed by the PVD thin-film deposition [4]. Another commercialized and widely used antiwear and engine parts repairing coating belongs to so called triboceramic compositions with the general formula Mg_s(Si_tO_{3t})(OH)_s. Commercially available triboceramic coating compositions mainly belong to materials developed by the use of natural minerals and data of the triboceramic coating forming compositions are available mainly from Russian Federation and Ukraine patent literature.

The present work is devoted to the study of crystalline phases of commercially available triboceramic compositions (HADO, FORSAN, RVS Finland, RVS Ruspromremont) evaluation of their effectiveness developing triboceramic coating using vibration test bench. Sol-gel technology was used to develop synthetic triboceramic compositions. Surface morphology of triboceramic coatings formed onto steel substrate by the use of commercially available triboceramic and sol-gel developed synthetic compositions was evaluated by atomic force microscopy (AFM).

Results of X-Ray diffraction analysis (XRD) confirms the application in commercial compositions the metal hydrosilicates with complicated chemical and phase composition which is formed by substances of complex octahedral and tetrahedral structure with characteristic Si-O-Si; Si-O-OH-M bonds. Main crystalline phases detected by XRD are hydrosilicates which packets of silicate structures are bonded together by weak van der Waals bonds that is why that can easily disunite as also slide between each other. Sol-gel method was realized using reagents $\text{Si}(\text{C}_2\text{H}_5\text{O})_4$, $\text{Mg}(\text{CH}_3\text{COO})_2 \cdot 4\text{H}_2\text{O}$, H_2O , $\text{C}_2\text{H}_5\text{OH}$ and various heat treatment temperatures which assures synthesis of karpinskite - $\text{Mg}_2\text{Si}_6\text{O}_{10}(\text{OH})_4 \cdot 2\text{H}_2\text{O}$, sepiolite $\text{Mg}_2\text{Si}_6\text{O}_{10}\text{O}_{15}(\text{OH})_4 \cdot 6\text{H}_2\text{O}$ as also periklaze MgO and forsterite $\text{Mg}_2(\text{SiO}_4)$.

Literature

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