

## **Ti-Mo-N Nano-Grains Embedded into Thin MoS<sub>x</sub>-Based Amorphous Matrix: A Novel Structure for Superhardness and Ultra-Low Wear**

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**Abstract :** Molybdenum disulfide (MoS<sub>2</sub>) represents a highly sought lubricant for reducing friction based on intrinsic layered structure, but for this reason, practical applications have been greatly restricted due to the fact that its low hardness would cause severe wear. Here, a novel TiMoN/MoS<sub>x</sub> composite coatings with TiMoN solid solution grains embedded into MoS<sub>x</sub>-based amorphous matrix has been successfully designed and synthesized, through magnetron co-sputtering technology. Desirably, in virtue of such special microstructure, superhardness and excellent toughness can be well achieved, along with an ultra-low wear rate at  $\sim 2 \times 10^{-11}$  mm<sup>3</sup>/Nm in the air environment, simultaneously, low friction at  $\sim 0.1$  is maintained. It should be noted that this wear level is almost two orders of magnitude lower than that of pure TiN coating, and is, as we know, the lowest wear rate in dry sliding. Investigations of tribofilm reveal that it is amorphous MoS<sub>2</sub> in nature, and its formation arises directly from the MoS<sub>x</sub> amorphous matrix. Which contributes to effective lubrication behavior, coupled with excellent mechanical performances of such composite coating, exceptionally low wear can be guaranteed. The findings in this work suggest that the special composite structure makes it possible for the synthesis of super-hard and super-durable lubricative coating, offering guidance to synthesize ultrahigh performance protective coating for industrial application.

**Keywords :** hardness, MoS<sub>2</sub>-containing composite coatings, toughness, tribological properties

**Conference Title :** ICTFTA 2018 : International Conference on Thin Film Technology and Applications

**Conference Location :** Barcelona, Spain

**Conference Dates :** December 17-18, 2018