# Transition metal dichalcogenides alloyed with carbon: a new class of self-lubricant coatings

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The wide family of transitional metal dichalcogenides (TMD) offers extremely low friction coefficients in dry sliding, and negligible wear. However, such favorable parameters are strongly limited by ambient conditions. The tribological performance is excellent at vacuum or inert atmospheres, but it deteriorates at presence of oxygen and, particularly, water vapour. To prepare homogeneous TMD films, the magnetron sputtering is one the most convenient method; moreover, it allows easy alloying of TMD with other elements.

Among TMD family, only $MoS_2$ and to some extent $WS_2$ were studied systematically, while other candidates, such us selenides or tellurides, stood partially aside. Our preliminary results showed that molybdenum diselenide was much less sensitive to air humidity than corresponding sulphide, and that $WS_2$ co-sputtered with carbon significantly improved tribological properties compared to pure $WS_2$. Therefore, we have decided to join both studies and deposit Mo-Se-C coating, which was expected to overcome humidity limitation.

The Mo-Se-C coatings were prepared by r.f. magnetron sputtering with carbon content from 29 to 70 at.% and hardness increasing with carbon content to a maximum value of 5 GPa. The coating microstructure of selected samples was investigated by transition electron microscopy (TEM) showing randomly oriented platelets of $MoSe_2$ embedded in amorphous carbon matrix. The friction of Mo-Se-C coatings considerably decreased with increasing contact pressure to values as low as 0.02 at humid air and the coatings withstood long-term tests with hundreds of thousands cycles on pin-on-disc. The wear track characterization revealed the formation of pure $MoSe_2$ thin tribolayer on the surfaces in the contact influencing tribological behaviour and progressive reorientation of $MoSe_2$ platelets, which is considered to be dominant feature driving sliding process.

**Topic: Hard Coatings**