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6.	**Description in 500 words:** The fabrication of transition metal nitride coatings with desirable microstructural characteristics in terms of grain size, crystallographic orientations, lattice defects, and surface morphology as well as phase composition is very important in realizing the improved tribological properties hitherto unachieved in the literature. It is possible only through the thorough understanding of the influence of process variables, in the physical/chemical vapor deposition techniques, used for the fabrication of hard coatings. Although literature is available on sputter deposited transition metal nitride coatings, there is no single processing window with the optimized process conditions for achieving the desired microstructural morphology of the hard coatings, probably due to their high sensitivity/complexity of the environmental factors manifested in the vacuum chamber employed in various physical vapor deposition techniques. Therefore, it is essential to investigate the influence of sputtering process parameters for achieving the desirable microstructural characteristics with enhanced tribological properties in transition metal nitrides coatings. The main objectives of the present work was i) To synthesize Cr, Ti and W base transition metal nitride coatings on stainless steel substrates by DC/RF magnetron co-sputtering or multilayer technique, ii) To study the effect of various sputtering process parameters on the phase formation and microstructural characteristics of these coatings by XRD, FE-SEM/EDS, and AFM, and iii) To measure the mechanical and tribological properties of deposited coatings on stainless steel

substrates by microhardness / nanoindenter, and pin-on-disc tribometer, respectively. Following conclusion were made for the deposition of chromium based hard coatings with improved properties:

CrN Compound: The mechanical and tribological properties are influenced by the microstructure and orientation of the grains, which depends on the process parameters used during deposition of coatings by sputtering techniques. In the present work, the CrN coatings were deposited using simple DC magnetron sputtering with different argon:nitrogen gas proportions and in pure nitrogen environment without using biasing, during deposition, and keeping all parameter under precise controls. The hardness of CrN coating deposited with different argon:nitrogen environment was 21 GPa while the CrN coatings deposited in pure nitrogen environment was 27 GPa. The achieved hardness is in good agreement with the literature and moderately at the higher level. The higher hardness leads to improvement in tribological properties, which can be exploited for industrial applications.

CrSiN Compound: A small amount of silicon content (3.67 at.% Si) and the increase in nitrogen content contribute for the formation of CrSiN coatings. The CrSiN coatings consist of nanocrystalline CrN grains, show a columnar growth and become dense, with varying crystallite sizes for the increasing nitrogen content with small amount of Si content (3.67 at.%). The surface roughness of coatings is decreasing with increasing N_2 content during sputtering. The RMS values are found to be decreasing from 69 nm and 25 to 28 nm and 11 nm for SA304 and Si(100) substrates, respectively, with increasing substrate temperature from 373 to 773K.

CrAlN Compound: The mechanical and tribological properties of CrAlN coatings were evaluated in the present work. For CrAlN coating, the hardness is found to be varying from 18 GPa to 41 GPa, while the COF and wear rate varying from 0.3 to 0.84 and 3.36 X 10^{-6} mm^3/Nm, respectively. The hardness (*H*) and coefficient of friction (COF) were found to be 27.9 GPa and 0.4, respectively. The wear rate of the coatings is 1.38 x 10^{-6} mm^3/Nm. The CrAlN coatings with 33.98 at. % Al content gives best results and the components coated by the CrAlN coating could be better substitute for CrN and CrSiN coatings. The reduction in wear rate and COF indicates the better adhesion of coatings with the substrates, could be potential materials for machining industries. The hardness of CrAlN is found to be almost similar to the CrSiN coatings.

7. **Keywords:**
Hard Coating, Mechanical and tribological properties, Magnetron Sputtering, Transition Metal nitride