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Novel coating for improving tribological performances on rotating components of offshore wind turbines

Large capacity of wind turbines up to 10MW were preferred to install offshore to avoid negative scenery problem and noise pollution despite of its higher costs. As the turbine goes bigger, the mechanical components in the offshore wind turbine will be induced to higher stresses due to massive turbine blades weight and wind alteration. Thus, the gearbox system and main bearings become a critical component subjected to tribological conditions. The extreme static and dynamic loads will affect the fatigue life of the components to meet its design goals of 20 years minimum service life. Moreover, these parts should be corrosion resistant since they will be exposed to harsh seawater environments. In order to ensure that the tribological systems in wind turbine run smoothly, this system must be installed with sophisticated materials or coatings and equipped with effective lubrication systems.

One of the methods that can be applied to improve the tribological properties of the rotating parts of these turbines is surface treatments. Due to the large dimension of offshore wind turbine rotating components, only specific surface treatment methods can actually be employed. Among them, thermal spray is considered to be one of the most efficient and versatile techniques to obtain coatings of all classes of materials on large surfaces. Thermal spray coating generally use wire, rod or powder feedstock materials that pass through a high temperature regime generated by plasma or gas flame where they are fully or partially melted, accelerated in gas stream and impinged towards the substrate to form a coating layer by layer.

Todays, many of wear and corrosion resistance coatings are widely sprayed using flame spray, high velocity oxy-fuel (HVOF), detonation gun or atmospheric plasma spray (APS). Particular attention has been devoted in the very recent past to the possibility of depositing nano- (<100 nm) or sub-microstructured (100 nm – 1 µm) ceramic coatings to yield the potential of exceptional improvements of mechanical and tribological properties. Among the thermal spray processes that advance to achieve this goal is HVOF and APS technique utilizing suspension or solution precursor as it starting feedstock materials. These new systems circumvent the normal feeding problem with nano- and submicron particles and solve the handling difficulties when working with these fine particles.

The potential of suspension thermal spray (STS) and solution precursor thermal spray (SPTS) has driven the thermal spray researchers to explore these new systems to produce the oxide-based wear-resistant coatings (e.g. Al_2O_3, TiO_2, ZrO_2, Y_2O_3) starting from stabilized suspension containing dispersed fine particles and homogenous solution precursor containing dissolved metal salts, organometallic precursor or liquid oxide precursor. However, only few studies are focused on spraying carbide-based materials (e.g. SiC, TiC, WC) using these systems despite of the superior tribological properties of these materials. This circumstance arises due to the difficulties in spraying carbide- and nitride-based materials as they tend to decompose during elevated temperature process under atmospheric condition. This PhD ambition is to explore the possibility to produce carbide- and nitride-based coatings with focus on silicon carbide using the STS and SPTS systems. It is expected that the liquid carrier and correct recipe of SiC suspension+solution precursor can prevent the decomposition, enabling good quality and high strength SiC coatings to be attained. The thermally sprayed silicon carbide coatings owing its nano or submicro-structures are an ideal material for tribological application in wind turbines industries.