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DLC Deposited onto Nitrided Grey and Nodular Cast Iron Substrates: an Unexpected Tribological Behaviour

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1. Introduction

Applying a Diamond-like carbon (DLC) coating onto metallic substrates is a well-established solution to reduce wear and friction coefficient (COF) in tribological systems [1–5]. Enabling the use of DLC multifunctional coatings on substrate materials that bring lower cost maintaining the system performance is certainly a current challenge in industry and requires further research. Grey cast irons (GCI) and nodular cast irons (NCI) arise as potential candidates due their vast industrial applications such as large stamping tools [6], automotive parts [4,7,8], household appliances industry [9] among others. Yet, there is a surprisingly low amount of studies regarding the tribological behaviour of DLC coated grey and nodular cast irons substrates [6,7,10].

Naturally, the presence of near-surface graphite regions in these materials is a key issue regarding thin film applications, especially considering these graphite sites represent mechanical voids regardless of its morphology and, thus, spalling of coatings such as DLC may appear in these regions during tribological contact [11]. In fact, this aspect is so critical that it motivated the development of a surface treatment to remove all near-surface graphite prior to the nitriding of similar materials by different research groups [12,13]. Another very important issue is the relatively low hardness of cast irons metallic matrixes when compared with other commonly used substrates (i.e. AISI 52100 steel) [1,14–16], creating the necessity of developing a suitable mechanical support layer, being the nitriding of ferrous substrates a commonly used solution [6,10,17–20]

However, the plasma nitriding of grey cast irons strongly affects its topography, generating wedge-like features depending on the orientation of near-surface graphite flakes in relation to the surface, which was the subject of prior studies [10,21,22]. For nodular cast irons there is no such effect observed during plasma nitriding due the difference in graphite morphology [10,22], with only an increase of the overall roughness due the formation mechanism of nitride layers [23].