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# Abstract

Nowadays, the growing interest in carbon-carbon (C/C) composites, in a significant number of industrial contexts, has led to a major increase of research works aimed to investigate such materials. Being C/C composites used in many industrial applications, such as high-performance disc brakes, considerable numbers of studies focus on their tribological properties. Nevertheless, despite the large amount of works dealing with this topic, very few researches have been carried out so far on the relationship between the C/C frictional response and the onset of unstable friction-induced vibrations, as a function of the main contact parameters (e.g. sliding velocity, temperature, contact pressure, etc.). However, understanding and predicting the occurrence of undesired vibrational phenomena, taking place during frictional contact of C/C composites, is one of the greatest challenges in order to improve the overall braking performance.

In this regard, the study of friction-induced vibrations involves multiple scientific fields, especially considering the complex physiochemical characteristics of C/C composites and the strong influence of the operating conditions on the frictional response of such materials. Moreover, the significant impact of the third body on their tribological behavior requires a deep insight of the rheological mechanisms affecting the friction coefficient and the occurrence of contact dynamic instabilities.

Within this research framework, the present PhD thesis aims to investigate and characterize the onset of unstable friction-induced vibrations of C/C materials, under different contact conditions. Their frictional response and its relationship with the occurrence of dynamic instabilities have been investigated on linear tribometers aimed to characterize C/C specimens, under controlled boundary conditions. The specifically designed test benches have allowed studying the frictional and vibrational response of C/C samples, with particular attention on the role of temperature, up to almost 500 °C, sliding velocity and test environment. Meaningful information, so far missing in the literature, concerning the nature and the main characteristics of the dynamic instabilities caused by C/C materials in frictional contact, are presented in this work. Moreover, numerical models have been developed, in order to investigate the main features of the different vibrational phenomena. In this respect, the present work proposes a novel approach, based on the analysis of the phase shift between vibrational signals, in order to distinguish the onset of mode coupling or negative friction-velocity slope instabilities, as well as the coexistence of both phenomena.

Particular attention is also given to the role of the third body and its rheological contribution. The effect of metallic and non-metallic contaminants has been investigated as well, by contaminating the frictional surface of C/C material samples, tested under controlled boundary conditions. The relationship between the rheological contribution to the frictional response and the onset of dynamic instabilities in presence of distinct boundary conditions has been then investigated. The obtained results have allowed developing different scenarios describing the C/C tribological behavior and the occurrence of unstable friction-induced vibrations, taking into account the rheology of the contact during braking.

This PhD thesis has been carried out in collaboration between the Sapienza University of Rome, at the Department of Mechanical and Aerospace Engineering (Rome, Italy) and the Institut National des Sciences Appliquées (INSA) of Lyon, at the laboratory LaMCoS (Lyon, France).