Summary

Silicon (Si) is an element abundantly present on our planet, and precisely because of its abundance, research for its potential applications has always been very active in various fields of science and everyday life. Considering its properties, generally Si is regarded as an insulator at room temperature, but the introduction of impurities into a Si component allows modifying its conductivity. It is therefore possible to produce Si-based components with the presence of other materials such as C, B, Al, O, and others, not only for the production of useful conductive components in the field of electronic industry but also in automotive, aerospace, and even food packaging.

One of the most technologically interesting silicon-based systems is Silicon Carbide (SiC). It stands out as a leading advanced material, renowned for its exceptional properties and versatile applications spanning various industries. As a semiconductor, SiC boasts a remarkable blend of high thermal conductivity, exceptional mechanical strength, and a wide bandgap, making it well-suited for challenging environments in electronics, energy systems, and structural applications. Its superior attributes facilitate the development of efficient power electronics, high-temperature sensors, abrasion-resistant coatings, and aerospace components. Its resilience in extreme environments, resistance to corrosion, and durability against wear further enhance its suitability for applications in aerospace, automotive, and advanced electronics industries. Given the remarkable positive characteristics of SiC, new methods for manufacturing components using this material are actively being explored, with Additive Manufacturing (AM) emerging as one of these innovative approaches.

The possibility to produce SiC components through AM has emerged as a promising opportunity. The exceptional thermal conductivity, high-temperature stability, and superior mechanical strength of SiC, make it an appealing choice for various AM techniques. Nevertheless, challenges persist in SiC AM, such as achieving high-density parts with minimal defects, optimizing processes to prevent thermal stresses, and maintaining powder quality control. Overcoming these obstacles necessitates a thorough understanding of material behaviour during printing, the use of effective post-processing techniques, and the development of tailored AM methodologies.

In this work, we investigated the production of SiC components using two different AM techniques and following two distinct production methods. The first method, an indirect approach,

involved employing the Selective Laser Sintering (SLS) technique to produce samples of composite powder PA12-SiC with a high content of ceramic powder. The second method, a direct approach, aimed to achieve the in-situ production of SiC samples starting from Si and C powders following the Electron Beam–Powder Bed Fusion (EB-PBF) technique. In the first case, the aim was to demonstrate the possibility of producing samples with a high content of SiC and complex geometry using the SLS technique, thus verifying the actual SiC content. In the second case, the goal was to demonstrate the feasibility of in-situ production of SiC samples using the EB-PBF technique and then determine, through comprehensive characterization, the features, and properties of the obtained samples.