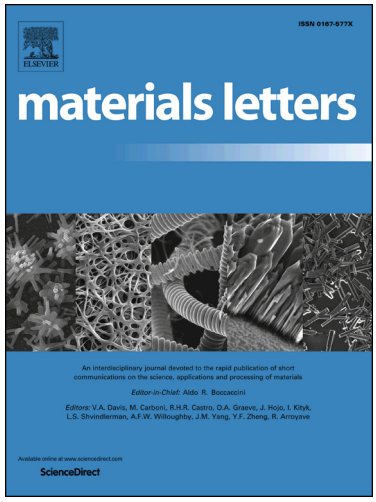


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# A novel method for in-situ synthesized TiN coatings by plasma spray-physical vapor deposition

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**Abstract**

As a novel process, the plasma spray-physical vapor deposition technology was used to in-situ synthesize the TiN coatings on the Ti-6Al-4V alloy. Due to its high power input and very low pressure, relatively pure TiN coatings with hybrid structures were successfully obtained at different spraying distances, which was not previously achieved with other thermal spraying processes. The results showed that the nitriding reaction occurred not only in the plasma jet but also on the substrate. Moreover, the spraying distance was found to affect the phase, microstructure, and mechanical property of the TiN coating. As a result, the mechanical properties of the Ti-6Al-4V alloy can be significantly enhanced by the TiN coatings.

**Keywords:** Titanium nitride; Nitriding reaction; Plasma spray-physical vapor deposition; X-ray techniques; Microstructure; Indentation and hardness

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## 1. Introduction

Titanium alloys have been widely used in the aerospace, marine, and medical industries due to their high specific strength, excellent corrosion resistance as well as unique biocompatibility [1]. However, they are rarely used in mechanical engineering applications because of their low surface hardness and poor tribological properties [2]. The poor mechanical performance can be improved by depositing TiN coating, which has high hardness and elastic modulus [3]. Generally, the TiN coatings are prepared by physical or chemical vapor deposition [4,5]. Nevertheless, due to the low deposition rate, the obtained TiN coatings are usually very thin (<10 μm), which limits the applications [6]. Therefore, using the reactive plasma spraying (RPS) to fabricate thick TiN coatings has been considered [7-9]. For example, Xiao et al. [7] prepared a more than 300 μm nanostructured TiN coating by the atmospheric RPS, but the layer contained $Ti_3O$ besides the main phase TiN. In addition, Vautherin et al. [8] fabricated a 27 μm TiN coating using the low-pressure RPS, despite there is no oxides in the coating, many $TiN_{0.3}$, $Ti_2N$, even unmelted Ti are presented because of the insufficient plasma power.