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# Preparation and Interface Analysis of Metal and Ceramic Composites

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## Introduction

The performance of single material has been difficult to meet the increasingly complex working conditions due to its own limitations, so the composite material is applied. The composite structure of heterogeneous materials not only has the advantages of various materials, but also can be used normally even under extremely harsh working conditions. At the same time, it can also replace the use of scarce materials to a certain extent and reduce costs, which has a very broad application prospect [1,2]. Such as ceramic, protonic ceramic fuel cells can directly use both hydrogen and hydrocarbon fuels to produce electricity at potentially more than 50 per cent efficiency [3,4]. Ceramics are also applied and reported as restorative materials for treatment of severe tooth wear and bearing was introduced in total hip arthroplasty due to its properties of high-wear resistance and biocompatibility were superior to those of the alloys and polymers [5-7]. Metal materials generally refer to pure metals or alloys in industrial applications, which have some characteristics such as crystal structure, gloss, electrical conductivity, good thermal conductivity and ductility in solid state. For example, stainless steel and iron based stainless steel Alloy materials are wear-resistant, high intensity and corrosion-resistant materials. They can be used in the protection of nuclear reactors, architecture field, west-east natural gas, and so on [8,9]. Titanium and its alloys with high specific strength, high temperature resistance, low temperature resistance, strong damping resistance and good corrosion resistance have been widely used in aerospace, ocean shipping, petrochemical, medical and other fields [10,11].

The use of ceramic metal composite armor in personal protection and armored vehicles not only realizes the lightweight of armor, but also further improves the performance of preventing weapons from penetrating. Metal ceramic coating is prepared on the surface of aerospace engine to improve the oxidation resistance and thermal shock resistance, so as to prolong the working life of the engine. Cutting tools and propeller shaft bearing sleeves can effectively improve the service life of materials and reduce the use cost by using the wear resistance of ceramic metal composite materials [12]. Therefore, the preparation of ceramic and metal composites plays an important role in the field of electronics, aerospace, ocean ships, nuclear engineering and military weapons. In this protocol, we provide two detailed manufacturing processes for preparing metal-ceramic composites, and analyze and summarize the microstructure, composition and structure of the metal-ceramic interface after reaction.

## Development of The Protocol

Ceramic and metal composite materials are widely used, but because ceramics are inorganic nonmetal materials, and metal materials have great differences in physical and chemical properties, which will cause great resistance in preparation. There are mainly the following problems to achieve efficient connection between ceramics and metals:

1) The chemical properties of ceramics and metals are quite different. Ceramic itself has good stability; bonding form is covalent bond. The nature of metal is more active, which was composed of metal bonds.

2) Both elastic modulus and thermal expansion coefficient of ceramics and metals have great differences. Therefore, the rapid rise and fall of temperature will lead to the extremely uneven distribution of thermal stress. As a result, a large amount of residual stress is easy to be generated, resulting in stress concentration at the reaction interface, which seriously leads to joint fracture.

3) Complex element reactions occur at the interface. The generation of some new compounds has brought great difficulties to the quantitative analysis of the types and components of the generated phases in the later stage.

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