# PROCESSING AND PROPERTIES OF TiC-$Ni_3Al$ COMPOSITES

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TiC-$Ni_3Al$ composites are under development for application in diesel engines because of desirable physical properties and wear resistance. $Ni_3Al$ is of interest as a binder phase because it is unusual in that the yield strength actually increases with increasing temperature up to about 800°C. Powder compacts with binder contents from 30-50 vol. % were fabricated by vacuum sintering followed by low gas pressure HIP. Increasing the $Ni_3Al$ content improved densification when using prealloyed powders as expected. However, when the $Ni_3Al$ was formed by in-situ reaction synthesis of Ni and NiAl, densification decreased with higher binder contents. The final microstructure consisted of a 'core-rim' structure with pure TiC cores surrounded by (Ti,W)C rims. Grain sizes of the TiC increased with binder content and temperature. Preferred orientation of the $Ni_3Al$ binder phase was observed due to very large grain sizes on the order of millimeters. Mechanical property testing shows that these composites have high fracture toughness (11-25 MPa√m) and hardness (6.5-10 GPa) depending on the binder content. In addition, these composites can also exhibit extremely high fracture strengths (e.g., in excess of 1 GPa), and these strength levels are retained at temperatures up to 800°C. The physical properties of these composites can be tailored by careful selection of binder composition and volume content. For example, in the TiC-$Ni_3Al$ system, the thermal expansion coefficient can also be varied (ranging from ~7 to 15 x $10^{-6}$/°C) by modifying the composition.

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