Use of Functionally Graded Interlayer to Improve Bonding in Coated Plates

Introduction

Coatings play an important role in a variety of engineering applications protecting metallic or ceramic substrates against oxidation, heat penetration, wear and corrosion.

Conventional coatings usually consist of one or two homogeneous layers deposited on a substrate; they are susceptible to cracking and debonding due to the mismatch of thermomechanical properties between the coating and the substrate.

The concept of Functionally Graded Material is currently actively explored in coating design to increase resistance of coatings to functional failure.

Functionally Graded Material (FGM) refers to a heterogeneous composite material with gradient compositional variation of the constituents from one surface of the material to the other which results in continuously varying material properties.

Theoretical Modelling

Coating design incorporating FGM concept

Conventional coating with homogeneous interlayer and homogeneous top coat (H-H coating)

Single layered FGM coating without interlayer (FGM-coating)

Coating with FGM interlayer and homogeneous top coat (FGM-H coating)

3-D displacement field

\[ G^{ii}(z) = e^{\beta z} \exp \left[ \gamma \left( \frac{x}{L_x} \right) \right] \]

For 3-D stress field use constitutive equations

Numerical Results

Out-of-plane stresses and displacements

In-plane stresses and displacements

Effect of stiffness gradient

The benefits of using FGM interlayer and homogeneous top coat instead of a single layered FGM coating:

• stress discontinuity is eliminated without increasing stresses at the top surface
• increase in transverse displacement is significantly smaller

REFERENCES