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Influence of heat flux and exposure time on the ablation performance of thermal barrier coatings on Ti-6Al-4V substrate for aerospace applications

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Introduction

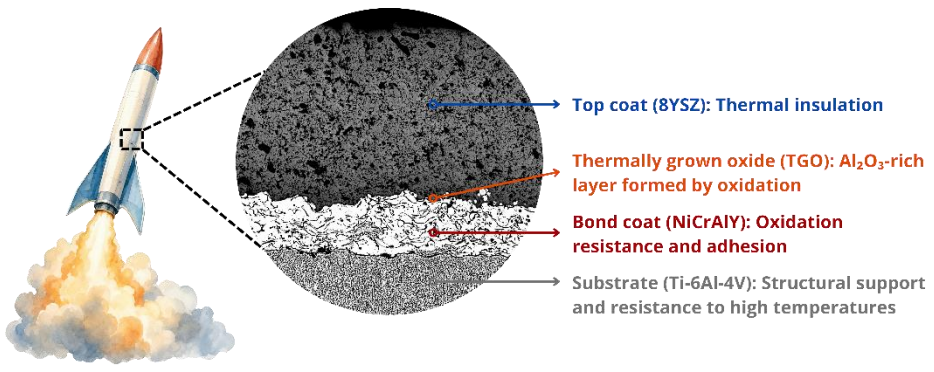


Figure 1. Schematic representation of a rocket during launch with thermal barrier coating (TBC) applied.

Objectives

To investigate the effect of heat flux (1.0, 1.5 and 2.0 MW·m^{-2}) and exposure time (10 and 30 s) on the mass variation and microstructural evolution of Ti-6Al-4V, comparing TBC-coated and uncoated specimens.

Methodology

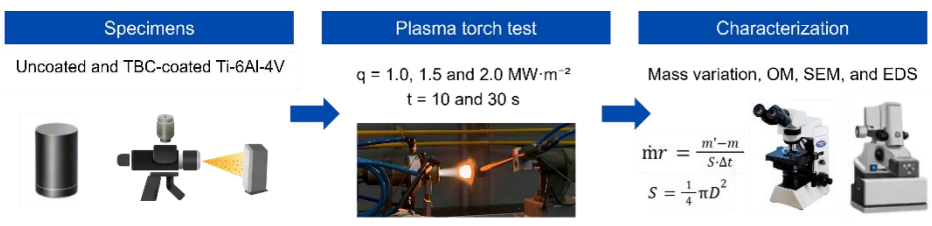


Figure 2. Flowchart of the experimental methodology.

Results and Discussions

Both mass gain and loss were observed. Mass gain may be associated with oxidation, whereas mass loss may result from material removal during thermal exposure [1,2].

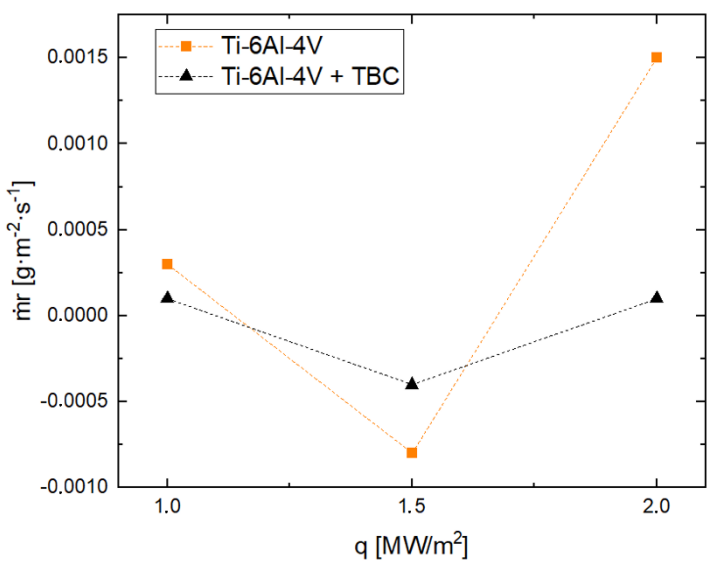


Figure 3. Mass loss rate due to ablation (ṁr) as a function of heat flux (q) for uncoated and TBC-coated Ti-6Al-4V samples after 10 s of exposure.

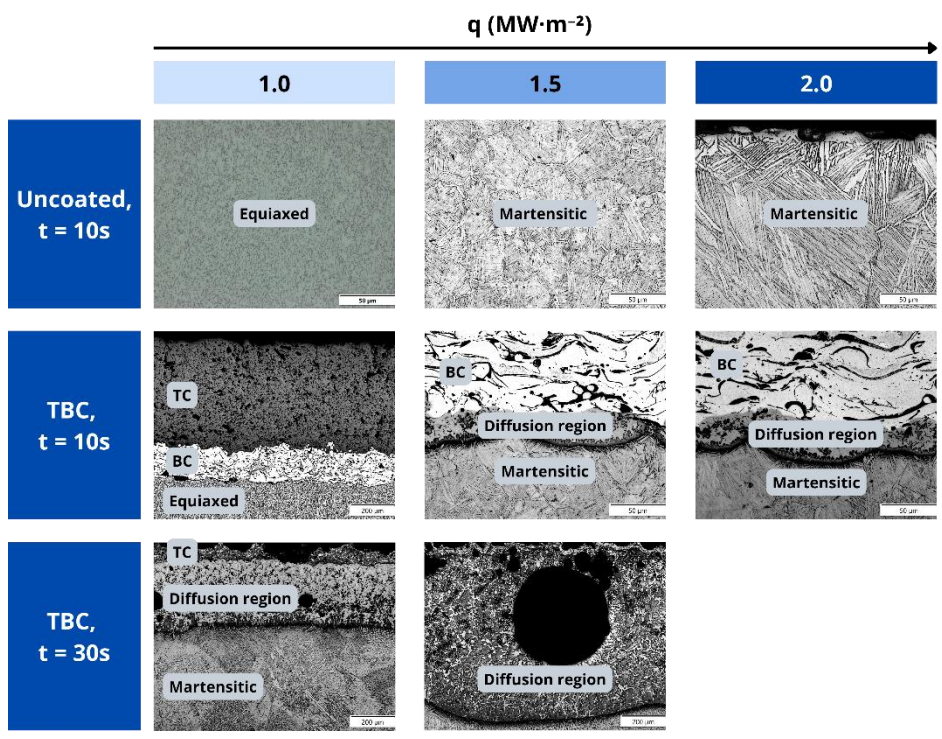


Figure 4. Cross-sectional micrographs of uncoated and TBC-coated Ti-6Al-4V specimens after plasma torch exposure at different heat fluxes and exposure times.

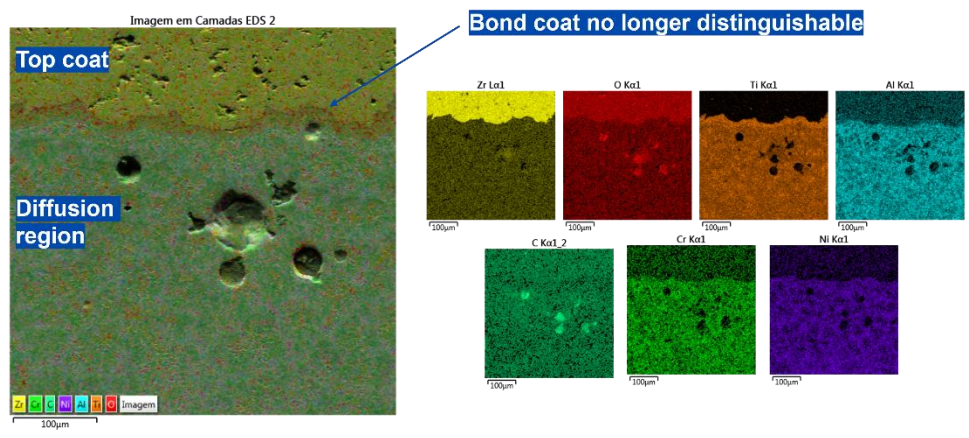


Figure 5. SEM-EDS elemental maps showing the TC and interfacial region after exposure at 1.5 MW·m^{-2} for 30 s, where the BC is no longer distinguishable.

Thermally induced interdiffusion and interfacial reactions may explain the diffusion regions and loss of a distinct bond coat, while the observed cavities suggest localized material removal during plasma-torch exposure [3].

Conclusions

- At 10 s, TBC-coated specimens exhibited smaller absolute mass variations than uncoated Ti-6Al-4V.
- TBC partially preserved the original substrate microstructure, whereas longer exposure promoted microstructural transformation.
- TC remained preserved under all investigated conditions.
- Increasing thermal severity promoted interdiffusion and, in some conditions, the loss of a clearly distinguishable bond coat.

References and Acknowlegments

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