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Creep behavior and scratch resistance of Ti-6Al-4V alloy uncoated, bond-coated, and thermal barrier coated

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Introduction

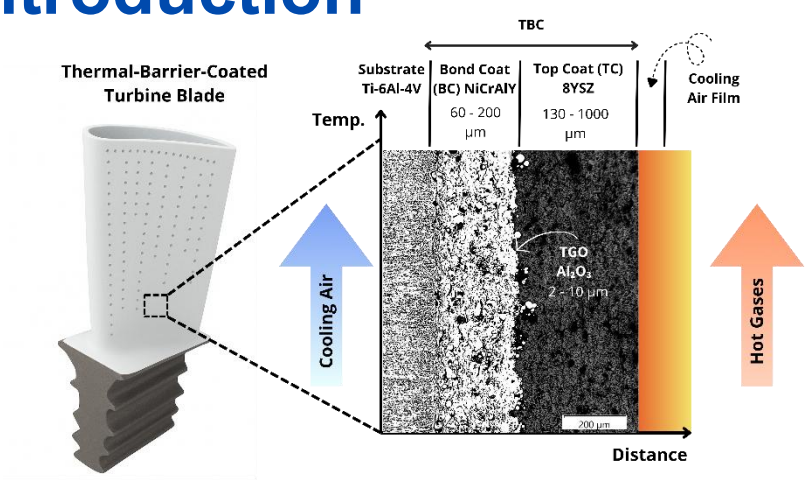


Figure 1. Schematic representation of a thermal barrier coating (TBC) applied to a turbine blade [1].

Objectives

To evaluate the influence of BC and TBCs on the microstructure, creep behavior, and scratch damage resistance of Ti-6Al-4V alloy for high-temperature aerospace applications.

Methodology

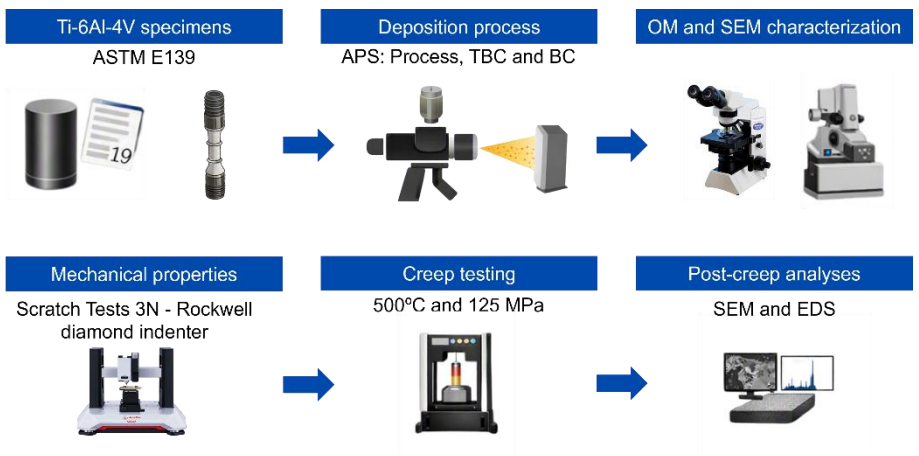


Figure 2. Flowchart of the experimental methodology.

Results and Discussions

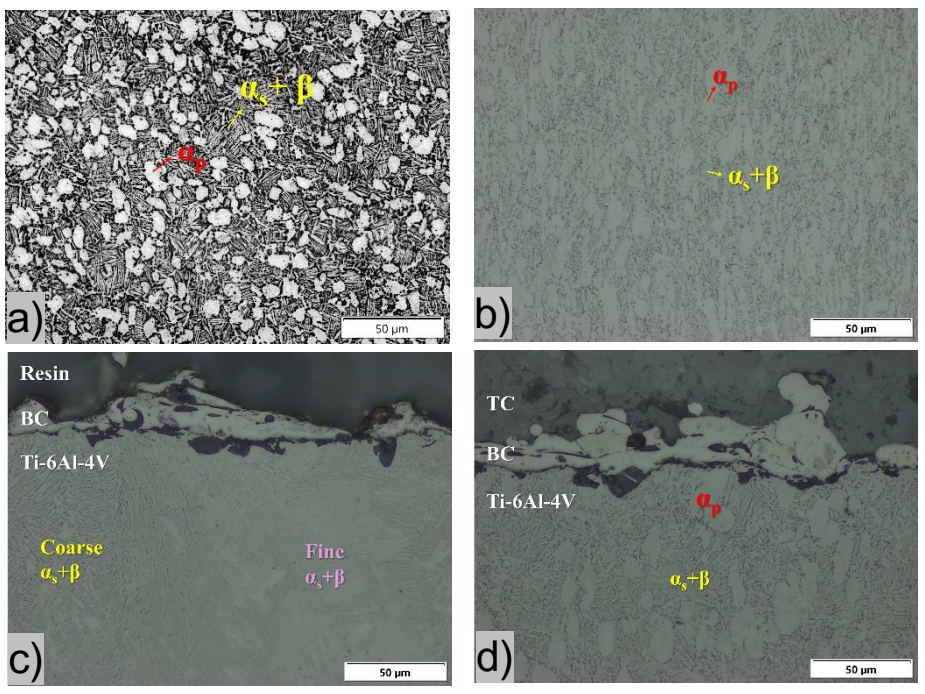


Figure 3. Initial microstructure of (a) uncoated, (b) APS-processed uncoated, (c) BC-coated, and (d) TBC-coated samples.

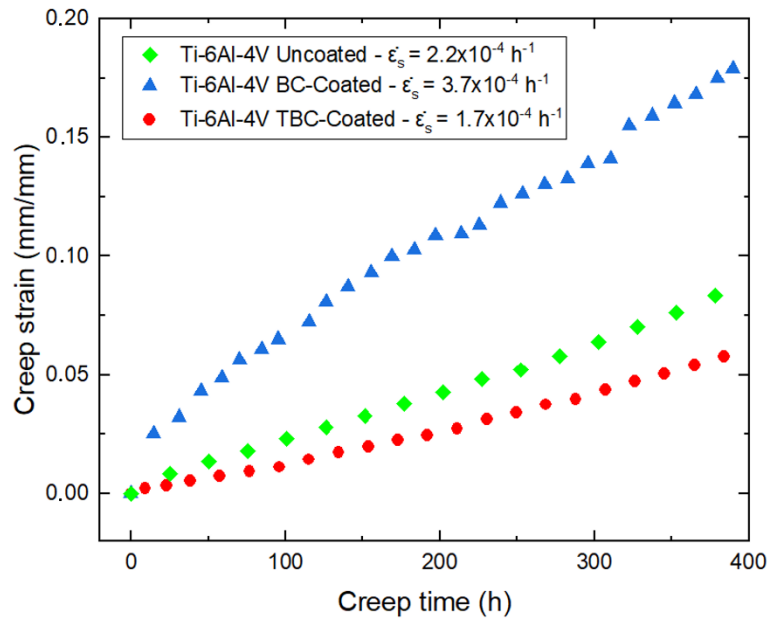


Figure 4. Creep curves, tested at 500 °C under a constant stress of 125 MPa, emphasizing the time interval up to 400 h.

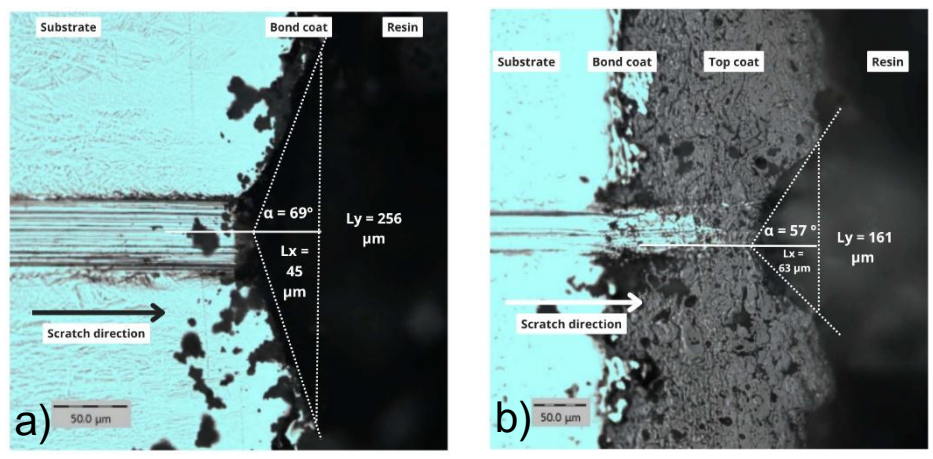


Figure 5. Cross-sectional scratch damage geometry for (a) BC-coated and (b) TBC-coated samples showing the measured parameters L_x, L_y and α.

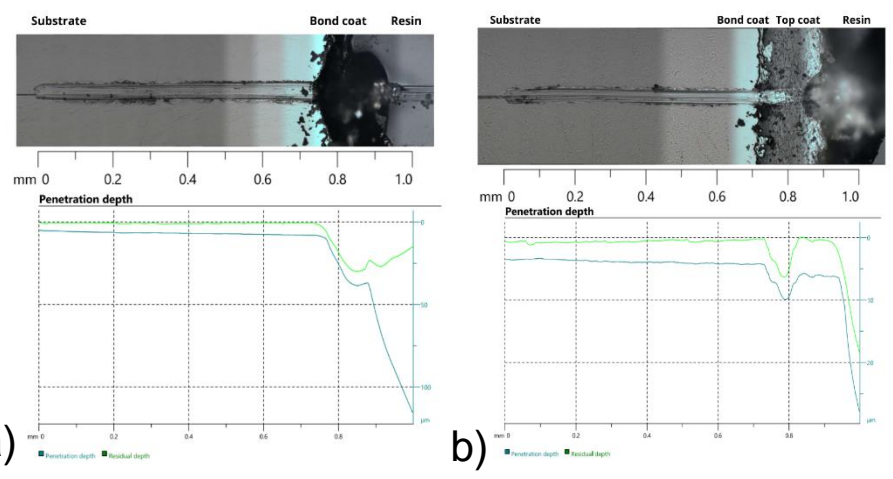


Figure 6. Penetration and residual depth profiles and corresponding cross-sectional images from scratch tests of (a) BC-coated and (b) TBC-coated samples.

Conclusions

- TBC reduced the creep rate by 23% when compared with the uncoated alloy.
- Scratch damage propagation and cone angle decreased by 37% and 17%, respectively, for TBC compared with BC.
- TBC improved creep resistance and scratch damage tolerance, highlighting its potential for high-temperature aerospace applications.

References and Acknowlegments

[1] REIS, D. A. P. et al. Historical development of creep research on thermal barrier coatings (TBCs) in Brazil: contributions from the Mechanical Behavior of Metals Laboratory (LCMM). In: Appl. Exact Sci. Differ. Contexts, p. 141-165., 2026. DOI: 10.35587/brj.ed.978-65-6016-158-0_8.
[2] LOPEZ, E. et al. Measurement of cohesion and adhesion strengths in alumina coatings produced by plasma spraying. J. Mater. Sci. Lett., v. 8, p. 346-348, 1989.
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