New solutions for joining oxide-based ceramic matrix composites that operate under extreme conditions to develop a sustainable process for the steelmaking industry

Carla Malinverni,[1,*] Milena Salvo,[1] Valentina Casalegno,[1]
Alessandro De Zanet,[1] Federico Smeacetto,[1] Fabiana D'Isanto[1]
[1] *Department of Applied Science and Technology, Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129 Torino, Italy*
*corresponding author: carla.malinverni@polito.it

Over the last years the steelmaking industry has been the subject of interest in the context of the ecological transition. One of the goals for this energy-intensive sector is to improve its production processes, so as to fulfill the low-carbon emission objective and decrease the energy inputs by using renewable sources. In order to make the production more environmentally and economically sustainable, radiant tube furnaces used in this sector are being manufactured with innovative and high performance materials, such as ceramic matrix composites (CMCs). This work is focused on the study and development of joining materials and processes for oxide-based ceramic matrix composites (Al_2O_{3f} /Al_2O_3-ZrO_2) for the production of these components. These joints operate at very high temperatures (above 1000°C) and in harsh environments, where they have to resist corrosion and humidity. New glass-ceramic systems are here proposed as joining materials with specific and optimized properties in order to withstand the severe operating conditions [1]. Novel glass compositions are formulated, fulfilling criteria of wettability, CTE matching and thermomechanical compatibility with the CMC substrate [2,3]. The joints obtained are morphologically and thermo-mechanically characterized. Additional experimental activity using novel brazing alloys as joining materials for ceramic matrix composites is also reported.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958170.

[1] Ferraris M., Casalegno V., Smeacetto F., Salvo M., Glass as a joining material for ceramic matrix composites: 25 years of research at Politecnico di Torino, *International Journal of Applied Glass Science*, (2020) 11:569–576.

[2] D'Isanto F., Smeacetto F., Martin H-P. et al., Development and characterisation of a Y2Ti2O7-based glass-ceramic as a potential oxidation protective coating for titanium suboxide (TiOx), *Ceramics International* 47, (2021) 19774–19783.

[3] Smeacetto F., Radaelli M., Salvo M. et al., Glass-ceramic joining material for sodium-based battery, *Ceramics International* 43, (2017) 8329–8333.