TWENTY YEARS OF EXPERIENCE WITH CARBON/CERAMIC BRAKES: STATUS AND PERSPECTIVES

Walter Krenkel, Ceramic Materials Engineering, University of Bayreuth, Germany
walter.krenkel@uni-bayreuth.de

Carbon/ceramic brakes can be regarded as a successful spin-off from space technology to terrestrial applications. First attempts in the nineties of last century started to use carbon fiber reinforced silicon carbide (C/SiC) as heat sink materials in high performance brake systems. Originally, these materials were developed for thermal protection systems (TPS) of spacecraft. Meanwhile, LSI-derived C/C-SiC composites have proven their outstanding performance for frictional applications by demonstrating high and stable coefficients of friction and low wear rates. Today, these ceramic composite materials are used in series products for high performance brake systems in automotive and industrial applications (e.g. brake discs, pads for emergency brakes of elevators). High coefficients of friction which are constant over a wide range of sliding velocities and pressures have been achieved with appropriate counterpart materials. Specific modifications of the C/C-SiC microstructure in terms of matrix composition, fiber dimension and thermophysical properties were necessary and result in composite materials which differ widely from the original TPS-material. The development of an automotive brake system comprising C/C-SiC brake discs and organic based pads led to a lifetime brake which makes a brake disc change obsolete. The further success of these innovative materials, however, is strongly dependent on the reduction of the production costs and the development of light-weight ceramic brakes with life cycle costs (LCC) comparable to the current cast iron brakes. The presentation describes the development and evolution of carbon/ceramic brake discs and pads over the last twenty years, summarizes the state-of-the-art, and gives a perspective to future demands and challenges in process technology and material development.