CHARACTERISATION AND EVALUATION OF COMPRESSION LOADED SEALING CONCEPTS FOR SOFC STACKS

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ABSTRACT

Glass-ceramics are well-established seals for SOFC stacks. Due to disadvantages like inherent brittleness, alternative sealing concepts are of increasing interest. Promising candidates are metallic seals, mica, ceramic fiber sheets and combinations of them. However, contrary to glass-ceramics, all these concepts require permanent sealing loads. The present work focuses on characterization and concept evaluation of the alternative seals with regard their sealing capability, the required load, plastic deformation and elastic recovery . All experiments were conducted at operating temperature of SOFC stacks (800°C) in air. In the case of metallic seals an insulating interlayer is a prerequisite to avoid short circuiting during stack operation. Thus it was also examined, whether pre-oxidation of the metallic seals via alumina scale formation on the ferritic steals provides electrical insulation without loss of gas tightness. The application potential of the alternative sealants in SOFC stacks is discussed.

ELASTIC RECOVERY AND DEFORMATION BEHAVIOUR

Different design and material variants of seals were tested to elucidate specific deformation characteristics at SOFC operating temperature (800°C). All variants were loaded two times up to 900 N. The elastic recovery down to a remaining load of 50 N was determined. Fig. 1 – 4 show load deflection curves of the investigated materials. In particular, mica paper seems to have the most promising recovery behavior (Fig. 2). On the other hand, high plastic deformation especially during the first cycle reveals that all seals should be pre-compressed prior to use in a SOFC stack. Based on these results, composite seals, which combine advantageously the metallic deformation with ceramic stiffness and exhibit gas tightness under SOFC conditions are proposed.

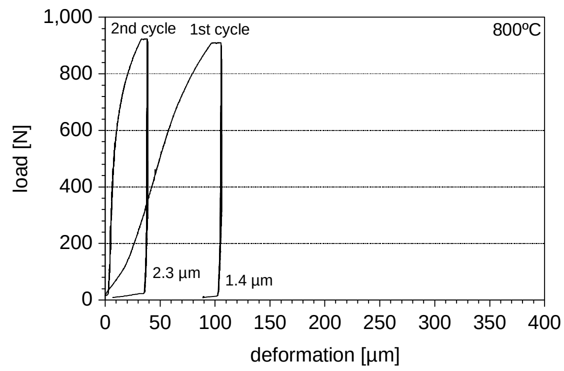

Fig. 1: Deformation behavior of a corrugated profile, height 1 mm, made of a ferritic steel sheet, thickness 200 µm (Aluchrom Y Hf^{TM}, Thyssen Krupp).

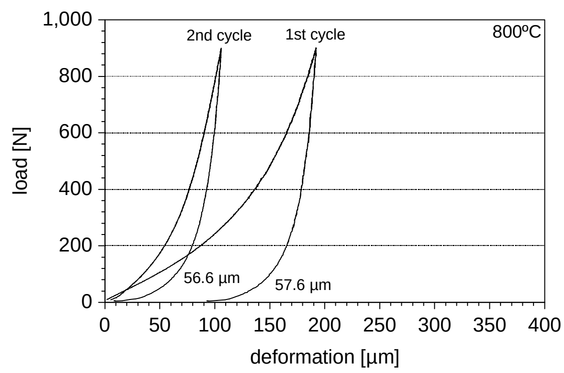

Fig. 2: Deformation of mica paper, thickness 1 mm, made of miglasil mica with binder (Statotherm, Burgmann).

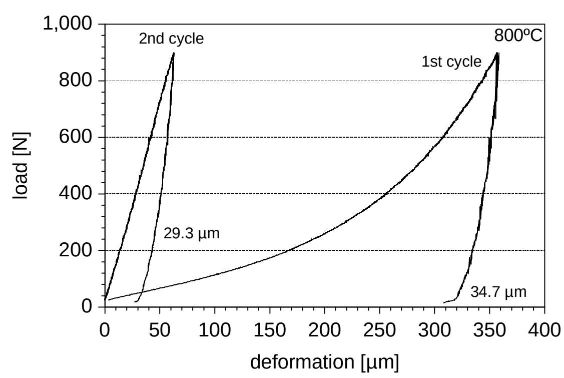

Fig. 3: Deformation behavior of commercial mica paper supported by a metallic inlay, thickness 1mm, made of vermiculite mica combined with 1.4401 steel sheet (Thermiculite 815^{TM}, Flexitallic).

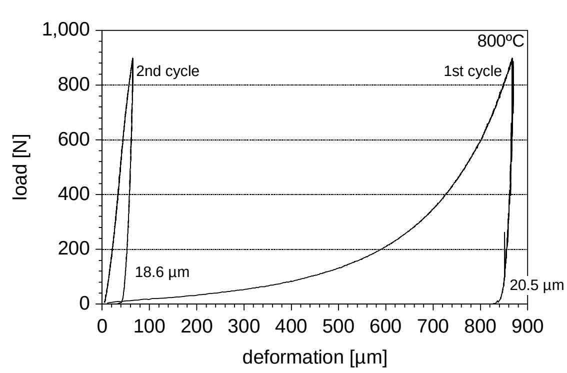

Fig. 4: Deformation behavior of ceramic paper, thickness 2 mm, made of ceramic fibers (Al_2O_3-SiO_2, Schupp Industriekeramik).