

EFFECT OF CYCLIC UNLOADING ON PRESSURE SOLUTION CREEP

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Pressure solution creep (PSC) is a fluid-assisted physicochemical process driven by the excessive stress-induced chemical potential of solids. The mass transfer is achieved through material dissolution at non-hydrostatically stressed sites, diffusion of solutes along the grain boundaries or pore space and re-precipitation at stress-free or hydrostatically stressed sites. The slowest of these three serial processes controls the overall deformation. PSC was studied on several salts in respective saturated aqueous solutions under static loading and cyclic unloading. Ball indentation and powder compaction curves show that each transition from static to cyclic regime may produce a dramatic increase — sometimes manifold — in PSC rate which lasts over the whole time of cyclic impact. After returning to static regime, the initial creep rate reappears. Over longer-term tests, both in static and cyclic regime, the creep gradually slows down. Increasing impact frequency enhances the effect. Any noticeable changes in strain rate are absent in a pure inert medium (paraffin oil). The magnitude of creep acceleration depends on applied stress, cycling frequency and testing history. Diffusion-limited PSC at the static regime (case of sodium chloride and calcium carbonate) is more favourable to the cyclic unloading effect than interface-limited PSC (ammonium nitrate). Possible mechanisms of the effect are discussed.