A NEW NANOINDENTATION CREEP METHOD USING CONSTANT CONTACT PRESSURE

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A new indentation creep testing method is proposed where the mean contact pressure is kept constant. An approach of the proposed method is quite different from conventional indentation creep experiments, where the load on the sample is kept constant and the hardness is constantly decreasing due to the increasing contact depth / area. In this newly developed constant contact pressure method (CCP), the mean contact pressure as defined through Sneddon’s hardness is kept constant, until a steady state strain rate is achieved. Besides controlling the mean contact pressure, the dynamic stiffness is furthermore used to assess the indentation depth, minimizing thereby thermal drift influence and pile-up or sink-in effects during long-term experiments. The CCP method has been tested on strain rate sensitive ultrafine grained (UFG) CuZn30, UFG CuZn5 as well as on fused silica, comparing the results to strain rate jump (SRJ) tests as well as to the CLH nanoindentation creep tests. With the CCP method strain rates from $5 \times 10^{-4}$ s$^{-1}$ down to $5 \times 10^{-6}$ s$^{-1}$ can be achieved, keeping the mean contact pressure constant over a long period of time, in contrast to the CLH method. Moreover at low contact pressures, the strain rate sensitivity exponent of the tested materials is strongly increasing. There the plastic zone is only slightly increasing and internal relaxation processes within the plastic zone dominate the deformation behaviour. The CCP technique thus offers new possibility of performing long-term creep experiments while retaining the contact stress underneath the tip constant.

Figure 1 – left: Contact pressure vs. indentation depth, right: contact pressure vs. indentation strain rate