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Correlated thermal motion of two liquid Pb inclusions on a dislocation in an Al-based alloy

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Thermal motion of a system consisting of two 14 nm and 15 nm liquid lead inclusions attached to the same fixed dislocation in Al - 0.65 at.% Pb alloy is studied in-situ at 447°C using TEM. Observation of their motion for 110 seconds was recorded on video and analyzed frame by frame. Random oscillatory motion of the inclusions in the vicinity of the dislocation line occurs as a result of their mutual repulsion and their repulsion from the fixed ends of the dislocation caused by the dislocation line tension [1–3]. The observed behavior of the inclusions is described qualitatively considering the fixed dislocation as an elastic string. The oscillations of the inclusions can be considered as their thermal motion in coupled potential wells. The effective potentials, in which the inclusions move, and the effective potential of their interaction are evaluated from the experimental data. One of the potential wells is shown in Fig. 1 (left). Also, a strong correlation in the thermal motion of the inclusions due to

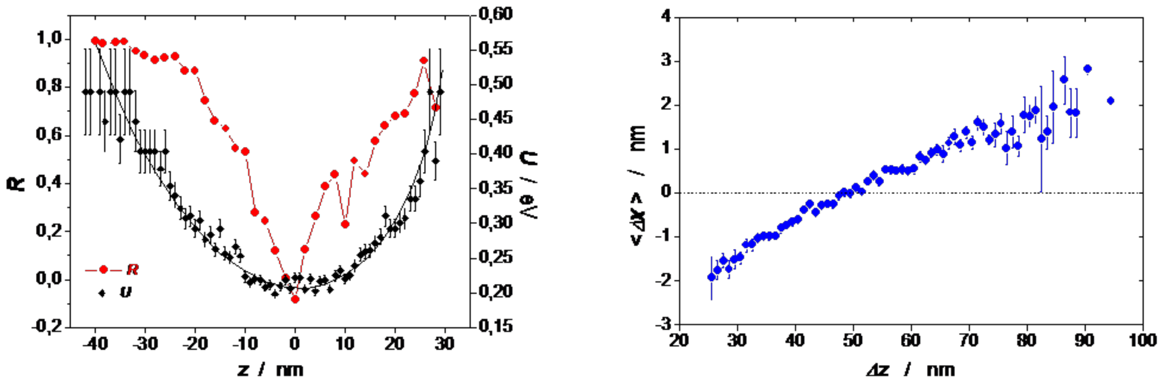

Figure 1: (left) Cross-correlation coefficient (R) of positions of the inclusions on the dislocation as a function of position of 14 nm inclusion in the potential well (U). The minimum of the potential well corresponds to $z = 0$. Solid lines are guides for eyes only. The values of R and U are obtained for 2 nm and 1 nm bins of z, respectively. (right) Averaged separation of the inclusions in the direction perpendicular to the dislocation ($\langle \Delta x \rangle$) as a function of their separation along the dislocation (Δz). The values of $\langle \Delta x \rangle$ are obtained by averaging of Δx over 1 nm bins of Δz.

their interaction is found as shown in Fig. 1. The first figure shows that the cross-correlation coefficient of the positions of the inclusions on dislocation varies from about zero in the centers of the potential wells, in which the inclusions move, to close to unity near the edges of the potential wells. The second figure demonstrates a strong correlation of the separation of the inclusions along the dislocation and their separation in the direction perpendicular to the dislocation.

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