On a New Wave Type Generated in Deforming Metal Crystals

Svetlana A. Barannikova, Lev B. Zuev, *Institute of Strength Physics and Materials Science, SB RAS, Tomsk, Russia.* E-mail: bsa@ispms.tsc.ru

Quasi-static deformation was studied on tensile fcc, bcc and hcp single crystals by holographic technique. It iahs been found that slow wave processes are generated in the deforming material. These involve concerted motion and temporal evolution of local flow nuclei whose nature is defined by micro-scale self-organization mechanisms.

The wave pattern type is determined for a given flow stage by work hardening law $\theta(\varepsilon)$, where $\theta = G^{-1} \cdot d\sigma/d\varepsilon$ is the work hardening coefficient; G, the shear modulus; σ, the plastic flow stress and ε, the deformation. The waves are characterized by wavelength $5 \le \lambda \le 10$mm propagation rate $10^{-5} \le V \le 10^{-4}$m/s and frequency $10^{-3} \le \omega \le 10^{-2}$Hz. The waves are found to exhibit the following regular features: wave rate $V = \Xi/\theta$, where $\Xi = const \approx 10^{-7}$m/s; quadratic dispersion law $\omega(k) = 1 + k^2$ and a concurrent decreases in the entropy of material by wave generation $\Delta S < 0$.

These can be likened to quasi-particles whose mass as calculated from the de Broglie equation for all the monocrystals tested $m = h/V \approx 1.5$amu and dimensionless mass $\mu = m/A$ (A is the respective metal's atomic mass) are found to grow with the number of electrons n per metal unit cell as $\mu = \mu_0 + \kappa n$.

Thus it is contended that by plastic flow slow waves would be generated spontaneously in a single metallic crystal, which is regarded as a complex thermodynamically open system. The nature of these wave processes and their role on plastic deformation are discussed.

Keywords: plasticity, wavelength, entropy