Abstract

The motivation for this work is based on a model from Ingomar Jäger and Peter Fratzl introduced in 2000. This model explains the mechanical behavior of bones. It consits of staggered mineral crystals in a collagen matrix.

One has further developed this model to fit on periodical structures of different but similar stiffnesses in composites on surfaces or in thin films. It predicts a resulting macroscopic stiffness as a function of the periodical structure size (period) respecting the principle 'smaller is stiffer'. This phenomen is quantitativly analyzed.

In this work, Laser Interference Metallurgy is introduced as a possibility for microscopic periodic metallurgical treatment of thin films as well as surfaces and coatings.

The periodic metallurgical treatment and its limits are simulated and analyzed. It is shown that the technique can manipulate periodically the phase microstructure. In this way, the microstructural texture, the residual stress situation, the grain size distribution and the phase formation are modified periodically. These controlled changes in the film result in periodic modulation of mechanical properties. Reduced Young's modulus and nano-hardness – measured by nanoindentational atomic force microscopy – are used to represent the mechanical properties.

Two macroscopically resulting properties of Laser Interference Metallurgy are shown using William Nix' substrate curvature method from 1989. Firstly, the microscopic modulated mechanical properties of the grown composite result in a higher macroscopic stiffness of the film. Secondly, the film stiffness is actually a function of the period of the Laser Interference Metallurgy. Thus, the stiffness is scaling with this period in the manner the model is predicting it.

Book

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