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NUMERICAL AND EXPERIMENTAL MICROSHEAR TEST FOR TIN NANOCOATING DEPOSITED ON POLYMER

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The Polish left ventricular assist device (RELIGA_EXT) [1] will be made of thermoplastic polycarbonate-urethane Bionate II with deposited biocompatible nanocoating of titanium nitride by pulsed laser deposition (PLD) method. Referring to the physical model, the two scale solid model [2] developed in the authors' finite element code was composed of a macro model of blood chamber and a micro model of wall of TiN/Bionate II. The numerical analysis of stress and strain states [3] confirmed the possibility of fracture [4], because of the big values of residual stress observed in the deposited TiN, and significantly different mechanical properties of the coating and substrate.

The proper design of multilayer wall of the medical device requires the knowledge of the real stress and strain states in the deposited coating. The mechanical properties of TiN nanocoating such as residual stress, material model and fracture model were determined in experimental and numercial nanoindentation [5,6] and *in situ* SEM microtension tests [7]. However, the complete stress state in the multilayer wall of VAD requires the microshear test results [8], and therefore, the *in situ* SEM microshear test was proposed in the present work. The shapes of samples TiN/polymer were developed basing on studies presented in [9,10].The simple shear test achieves large shear deformation without plastic instability in comparison with the uniaxial tensile test or the plane strain tensile test. Basing on experimental boundary conditions, the micro model of shear test was developed in the commercial 3D finite element code Abaqus. The FEM simulations and experimental tests were carried out to evaluate the effect of sample geometry on shear strain distribution, to study the effect of material parameters on the measured work hardening, and to correct the edge effect based on the geometry of test specimen. The correction method suggested for the simple shear test was validated experimentally.

Concluding, the FEM model of multilayer wall of VAD enriched with microshear stress data is able to predict the real states of stress and strain in 3D FEM models of VAD. Thus, in the future works the advanced fracture criterion can be applied to predict cracking of the 3D VAD construction following the methodology proposed in [11]. The developed model of wall of VAD enriched with the extended fracture criterion can be applied in multi-criteria optimization of the construction. The choice of the best construction of wall of VAD will be realized by selection of material layers, substrates, thickness of material layers and selection of parameters of deposition process to obtain high quality coatings without fracture occurrence.

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