

Integral Measuring System for the Determination of the Handle of Knitted Fabrics. *Fibres & Textiles in Eastern Europe* 2009; 17, 6(77): 70-75.

3. Stempień Z. Effect of Velocity of the Structure-dependent Tension Wave Propagation on Ballistic Performance of Aramid Woven Fabrics. *Fibres & Textiles in Eastern Europe* 2011; 19, 4(87): 74-80.
4. Szablewski P. Numerical Modelling of Geometrical Parameters of Textile Composites. *Fibres & Textiles in Eastern Europe* 2008; 6(71): 49-52.
5. Grechukhin AP, Seliverstov VY. Mathematical Model of Plain Weave Fabric at Various Stages of Formation. *Fibres & Textiles in Eastern Europe* 2014; 22, 5(107): 43-48.
6. Barauskas R. Multi-Scale Modelling of Textile Structures in Terminal Ballistics. In: *6<sup>th</sup> European LS-DYNA Users' Conference*, 2007.
7. Ha-Minh C, Imad A, Kanit T, Boussu F. Numerical analysis of a ballistic impact on textile fabric. *International Journal of Mechanical Sciences* 2013; 69: 32-39, doi:10.1016/j.ijmecsci.2013.01.014.
8. Nilakantan G, Keefe M, Gillespie JW Jr, Bogetti TA, Adkinson R. A Study of Material and Architectural Effects on the Impact Response of 2D and 3D Dry Textile Composites using LS-DYNA. In: *7<sup>th</sup> European LS-DYNA Users' Conference*, 2009.
9. Nilakantan G, Keefe M, Gillespie JW Jr., Bogetti TA. Novel Multi-scale Modeling of Woven Fabric Composites for use in Impact Studies. In: *10<sup>th</sup> European LS-DYNA Users' Conference*, 2008.
10. Nilakantan G, Keefe M, Gillespie JW Jr., Bogetti TA, Adkinson R, Wetzel ED. Using LS-DYNA to Computationally Assess the  $V_0$ - $V_{100}$  Impact Response of Flexible Fabrics Through Probabilistic Methods. In: *11<sup>th</sup> European LS-DYNA Users' Conference*, 2010.
11. LS-DYNA, 2007, Keyword User Manual.
12. LS-DYNA, 2006, Teory Manual.
13. Zienkiewicz OC. *Metoda Elementów Skończonych*. Ed. Arkady, Warsaw, 1972.
14. Livermore Software Technology Corporation, Modelling of Composites in LS-DYNA.
15. Zacharski SE. Nonlinear mechanical behaviour of automotive air bag fabrics: an experimental and numerical investigation. The University of British Columbia, 2010.
16. Teijin Aramid, Ballistics material handbook, 2012.

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**The Scientific Department of Unconventional Technologies and Textiles** specialises in interdisciplinary research on innovative techniques, functional textiles and textile composites including nanotechnologies and surface modification.

Research are performed on modern apparatus, *inter alia*:

- Scanning electron microscope VEGA 3 LMU, Tescan with EDS INCA X-ray microanalyser, Oxford
- Raman InVia Reflex spectrometer, Renishaw
- Vertex 70 FTIR spectrometer with Hyperion 2000 microscope, Brüker
- Differential scanning calorimeter DSC 204 F1 Phenix, Netzsch
- Thermogravimetric analyser TG 209 F1 Libra, Netzsch with FT-IR gas cuvette
- Sigma 701 tensiometer, KSV
- Automatic drop shape analyser DSA 100, Krüss
- PGX goniometer, Fibro Systems
- Particle size analyser Zetasizer Nano ZS, Malvern
- Labcoater LTE-S, Werner Mathis
- Corona discharge activator, Metalchem
- Ultrasonic homogenizer UP 200 st, Hielscher

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*Textile Research Institute*  
*Scientific Department of Unconventional Technologies and Textiles*  
Tel. (+48 42) 25 34 405  
e-mail: cieslakh@iw.lodz.pl