TENSILE PROPERTIES OF KNITTED FABRICS FOR EMR SHIELDING

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Abstract: The development of new materials for EMR shielding and their shielding properties characterization are of great research interest [1], [2], [3]. These materials have good functional and thermo-physical properties. Investigation of the mechanical properties of shielding knitted fabrics is very important as well, for estimating the appearance of the product, the comfort of its operation. At the same time the main mechanical property of knitted fabric, which affects the design, manufacture and operation of the product, is tensile [4]. For this study, the half Milano rib knitted structure was chosen as in the previous study it demonstrated the highest shielding efficiency [2] and good thermo-physical properties [3] due to the arrangement of the structural elements. Samples were produced on 8 gauge flat knitting machines, using 0.12 mm diameter stainless steel (SS) wire and 30 x 2 tex cotton yarn. The reference sample (sample A) of half Milano rib is knitted from cotton yarn only. The two variants of on introduction of the stainless steel wire into the knitted structure were used. Firstly (sample B), SS wire and cotton yarn were fed separately and feeders were changed after every two courses. As a result, 2 courses of rib 1x1 are formed from cotton yarn and 2 from a SS wire according to the interlooping repeat (Fig. 1 a). Secondly (sample C), the SS wire was fed to the knitting area along with the cotton yarn. Therefore, all structure elements are formed from both cotton yarn and SS wire (Fig. 1 b).

a b

Figure 1 Photos of knitted fabrics: a – Sample B; b – Sample C

The tensile properties of knitted fabrics were measured by KES-F (Kawabata Evaluation System), Tensile and Shear Tester (KES-F-1). The parameters obtained for tensile hysteresis curves are defined in Table 1.

Table 1 Tensile properties of knitted fabrics

Sample	Direction	Parameters			
		LT *[-]*	*WT* *[gf.cm/cm²]*	*RT* *[%]*	*EMT* *[%]*
A	wale	0.940	1.505	37.93	13.578
	course	0.800	4.245	34.08	44.726
	average	0.870	2.875	36.00	29.151
B	wale	0.747	1.074	28.69	12.050
	course	1.002	0.903	65.54	7.726
	average	0.874	0.989	47.12	9.888
C	wale	1.838	0.107	60.00	0.491
	course	1.085	0.571	42.25	4.450
	average	1.461	0.339	51.12	2.470

As is known from previous studies [4], the LT parameter characterizes the linearity of the tensile curve and is an indicator of wearing comfort. As the value of LT increases, the extensibility of the knitted fabric decreases in the initial range of deformation, which indicates a more stable structure of the knitted fabric and the product from it. Of the three tested samples, Sample C has a more stable structure, in which the SS wire was fed to the knitting area along with the cotton yarn ($LT_{average}$ = 1.461). The structure of the fabric becomes more stable compared to cotton Sample A ($LT_{average}$ = 0.870). The next indicator of the shape stability of the knitted fabric is its resilience. Resilience characterizes the stability of the knitted product throughout the entire period of its operation and evaluates the ability of the fabric to restore its original shape after removing the external load. RT is the parameter by which the fabric's ability to recover after tensile deformation is numerically evaluated. Sample A is characterized by the lowest RT value, which indicates the softness of the fabric ($RT_{average}$ = 36.00). With an increase in the amount of steel wire in the structure of the knitted fabric of Sample B (SS - 7%) and Sample C (SS - 29%), the tensile strength increases ($RT_{average}$ = 47.12) and ($RT_{average}$ = 51.12), respectively. Higher tensile resilience ensures greater stability of the dimensions of knitted fabrics after removal of deformation. As the tensile strain (EMT) increases, the elasticity of the fabrics decreases, that is, the shape stability and ability of the knitted fabrics to return to their original shape and size decreases. Of the investigated fabrics, Sample A has the highest tensile strain value ($EMT_{average}$ = 29.151). The knitted fabric with the highest content of steel wire Sample C (SS - 29%) has the lowest value of tensile strain ($EMT_{average}$ = 2.470). As the tensile strain (EMT) decreases, the tensile energy (WT) also decreases. Low extensibility of knitted fabrics corresponds to low tensile energy, while the tensile resilience increases. These regularities are observed for all tested samples of knitted fabrics.

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