elastomer was much more stable: E' at t= –50°C increased approximately 15 times, and E' – in 70.

The analysis of the temperature dependences of the loss tangent ($\tan\delta = E''/E'$) (Fig. 4) showed that when both in case of micro and nanoshungite fillers added, the characteristic peaks corresponding to the glass transition temperature shifts toward increasing it: from –45°C (pure elastomer) to –25°C (volume concentration 27%).

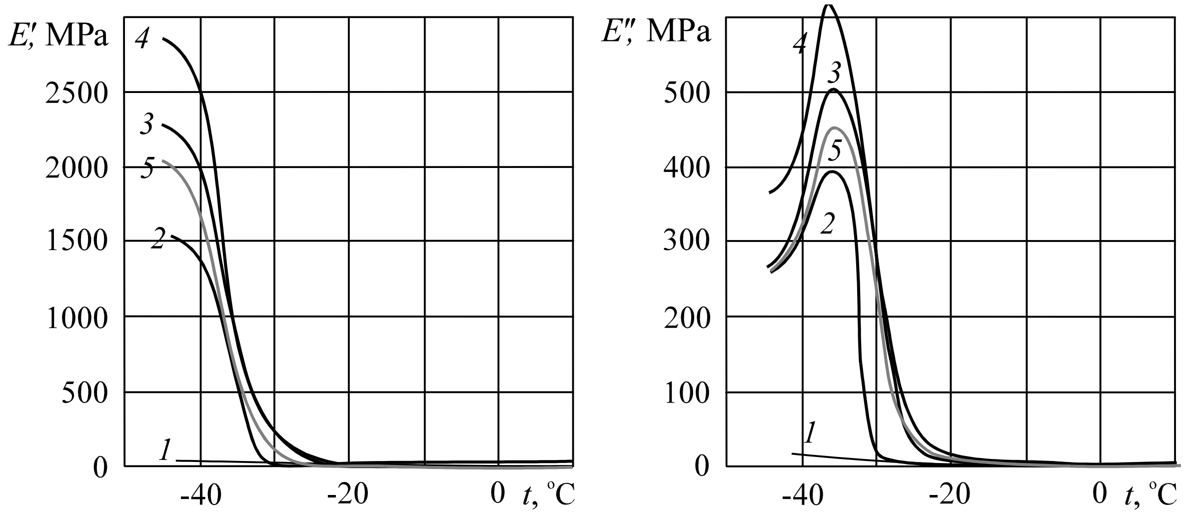

Fig. 3. Temperature dependences of dynamic (E') and viscous (E'') modules for rubbers filled with micro and nanoshungite particles. Microshungite filler (black lines): φ=0% (*1*), 10% (*2*), 18% (*3*), 27% (*4*); nanoshungite filler (gray line) – φ=18% (*5*)

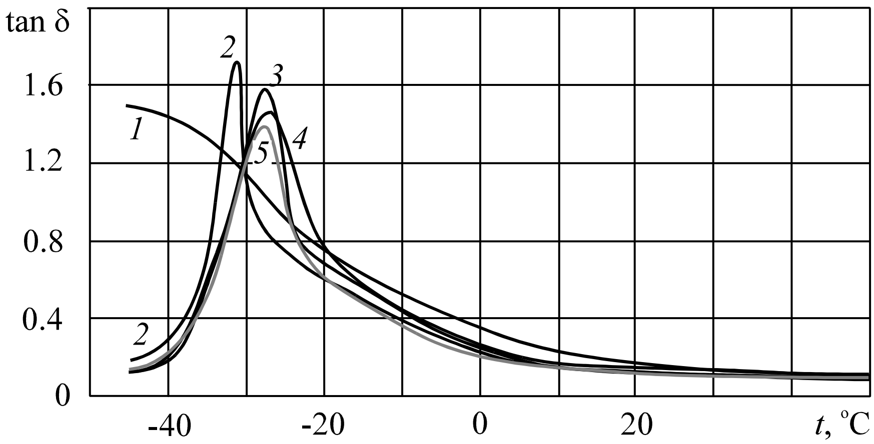

Fig. 4. Temperature dependences of loss tangent for rubbers filled with micro and nanoshungite. Microshungite filler (black lines): φ=0% (*1*), 10% (*2*), 18% (*3*), 27% (*4*); nanoshungite filler (gray line) – φ=18% (*5*)

Consequently, the use of tires with only such fillers in such low temperatures is quite problematic – some special additives are needed in the tire compound in this case.

4. Conclusions

The addition of dispersed mineral filler from micro and nanoshungite to tire rubber improves their strength and deformability, moreover in the case of nanoparticles this effect is enhanced. Studies of these rubber composites on dynamo-mechanical analyzer showed that they have stable viscoelastic properties at temperatures above -25 ° C, that is, they are quite suitable for operation in temperate climates.

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