

## Bells: the past and the present

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Bell is a part of history of Russia, a work of founding craft and art, a musical instrument. Myths and legends that arose around the bell casting craft and its 'material base' the bell alloy are of considerable research interest.

The metalgraphic study of the material from which the Vyatka church bells of the 19th century, rich in overtones were made, its spectral and chemical analysis has been done at the chair of metal study at the VyatSU. In the cast condition the structure of bronze was of clearly seen dendrite character. Because of the highly developed intradendrite liquation the composition of grains in the center is impoverished with tin, whereas the outward layer is enriched with it the dendrites have dark 'framing'. The eutectoid consisting of the  $\alpha$ -solid solution rich in tin and  $\delta$ -phase is located in the form of sinuous inclusions in the interdendrite space.

The set of properties of the bell bronze is formed by the ratio of the two main phases: a very brittle  $\delta$ -phase a bearer of the acoustic properties and a plastic  $\alpha$ -phase a bearer of the mechanical properties. The  $\delta$ -phase ( $\text{Cu}_{31}\text{Sn}_8$  compound) with the complex cubic lattice of the brass type belongs to a specific group of metal compounds electronic phases of Yum-Rosery.

Complex reserch of high-tin bell bronzes was made and technological methods of how to improve their operating properties, namely damping capacity, were developed.

Castings with the optimal tin content for the bell bronze (22% of mass) were made as a material for research. Regularities of influence of the material structure obtained by combining its modification with various versions of thermal treatment on the main operating characteristic of the product its damping capacity, were revealed.

The results of the work have shown new technical opportunities for increasing sonorousness of bells by changing the structure of bronze with the methods of thermal treatment, which will allow to cast bells with the preset time of sound. Moreover, the technology of thermal treatment developed allows to restore the historic bells which lost their sonorousness because of the aging processes in their structure (life of a bell is known to be 70-100 years).