Problem of welding of dissimilar materials often found in industry. Such joints are typical for parts of light constructions, ship and fuel apparatus, tanks, accumulators and so on. Best results for this case are obtained using laser welding, but process complexity complicates the experimental selection of process parameters. Solution is to use physically-adequate mathematic process-model, taking into account the difference in thermal properties of welded materials, diffusion and kinetics of phase transformations, defining formation of intermetallic phases.

Technology of laser welding of dissimilar materials are complex multivariable processes, and the correct choice of welding parameters in each case requires either a large amount of technological experiments or calculations using adequate mathematical models, that describe the processes of formation of the welded joint. Therefore, it is necessary to construct and validates a mathematical model to predict the structure of the weld metal for welding of dissimilar materials, as well as the study of the features of its application to select welding technology and parameters of welding mode.

For modeling of the weld structure formation the CAE system LaserCAD [1] was used. It allows to predict the size and shape of the weld pool, and analyze changes in chemical composition of the weld metal during welding, to predict the structure and properties of the weld metal and heat affected zone.

However, models of thermal, hydro and gas-dynamic processes used in LaserCAD do not allow its use for modeling of welding of dissimilar materials, and therefore face the task of creation of methods for calculating temperature fields, the size and shape of the weld pool in laser welding of dissimilar materials. Such model, based on analytic solution of heat transfer problem for the case of welding of dissimilar materials has been developed and verified.

To predict a phase structure of weld seam a diffusion-reaction model of phase transformations and formation of intermetallic phases has been developed also.

Results of numeric experiments with developed models showed, that shortage of the time of material presence in high temperature region make an effect on formation of zone of diffusion mixing, in which intermetallic precipitation is possible. Distribution of components across this zone is given by solution of diffusion problem with consideration of temperature dependence of diffusion coefficient. The typical size of intermetallic inclusions in this case was obtained from solution of task of inclusion growth due to common effect of diffusion and chemical reaction of intermetallic formation, accordingly [2], in one-dimension approximation. Simulation results shown, that in the case of high value of welding velocity it is practically possible to avoid appearance of continuous intermetallic layer in weld joint.

To provide high value of welding speed with penetration depth in the range 2-10 mm it was necessary to choose laser of high power with high quality of radiation. Due to this requirements all experiments have been provide with machine for laser and hybrid welding on the base of 15 kW fiber laser, designed in Institute of laser and welding technology of SPbSPU [3]. For research such materials as construction steel, stainless steel, Al-alloy 5083, technic copper and technic titanium have been used.

Metallographic examination of welds were performed on DMI 5000 microscope (Leica), software Tixomet. To determine the microstructure the alternately etching was used - first etched aluminum alloy. For etching steel used a solution of nitric acid in alcohol for copper alloys - an aqueous solution of ferric chloride. Study of the chemical composition and distribution of chemical elements in the weld made with a scanning electron microscope Mira Tescan using consoles Oxford INCA Wave 500. Microhardness was determined by MicroMet 5103, load 0.2 kg. Mechanical tests were carried out on flat specimens testing machine Zwick/Roell-Z100. For phase analysis the XPS and XRD methods was used.

On the base of obtained results it is possible to conclude, that model of laser welding of dissimilar materials, containing heat transfer, diffusion and phase transformation models, allow to predict temperature field, distribution of concentration and precipitation dynamic in weld joint and mixing zone. The developed model has been verified on Al-Fe, Al-Ti, Cu-Al and Cu-Fe systems. Fulfilled experiments proved a model-basier proposition that usage of high welding velocity and defined value of beam shift from the joint practically allow to avoid appearance of valuable intermetallic layer in the mixed zone during welding of dissimilar materials. So that laser welding due to possibility to precisely control by kinetics of fast phase transformation, allow to get high quality joints of dissimilar materials in wide range of thickness.