A droplet flowing over onto a plate introduced from above has been used to study the kinetics of spreading and to describe the observable characteristics of spreading of tin on iron, cobalt, nickel, and the intermetallic compounds Ni$_3$Sn, Ni$_3$Sn$_2$ under a vacuum of (2-4)$\times$10$^{-3}$ Pa at 400-1000°C, droplet mass 0.01-0.06 g. We show by a formal kinetic analysis of experimental data that in the low-temperature range (400-500°C) the kinetic regime dominates, and in the high-temperature range (600-1000°C) the inertial-kinetic regime dominates. In spreading of tin on iron, cobalt, nickel, and the intermetallic compounds Ni$_3$Sn and Ni$_3$Sn$_2$, the nature of the interaction corresponds to the phase equilibrium in the studied systems. The results for the kinetics of spreading of tin on nickel and the intermetallic compound Ni$_3$Sn showed that spreading of the main bulk is preceded by spreading of a precursor film.

On the one hand, determination of the kinetics and mechanism of spreading, in most cases complicated by processes of dissolution, diffusion, adsorption, and also reactions leading to formation of new phases at the interphase solid-melt, is a problem in the physical chemistry and physics of surface phenomena; on the other hand, it is very necessary for improving technological operations involving liquid phase.

The objective of this work was to systematically study the kinetic characteristics of spreading in metallic systems with formation of intermediate phases. The objects of investigation were binary systems of tin with iron group metals and the nickel stannides Ni$_3$Sn and Ni$_3$Sn$_2$. There is practically no information in the literature on the kinetics of spreading of tin on metals in the iron group, including the initial stages of the process [1]. This investigation is of practical importance because of the possibility of using data on the spreading kinetics of tin on iron group metals and their stannides for optimization the technology for application of tin coatings on steel, for creating new solders, improvement of the service characteristics of heat exchangers in which tin is a component of the liquid-metal heat transfer agents, etc.

The starting materials were tin OVCh-000 (99.999 mass % Sn), electrolytic cobalt (99.99 mass % Co), iron and nickel carbonyls (99.99 mass % of the base metal). The iron and nickel powders were remelted and also the nickel stannides Ni$_3$Sn and Ni$_3$Sn$_2$ were melted in an arc furnace under argon followed by chill casting. Metallographic studies were done to confirm that the compounds were single-phase. Spot checks of the intermetallics were done by local x-ray spectral analysis. From the ingots we cut plane-parallel plates of thickness 2-3 mm. The working surface of the plates was treated until it matched Class 12 cleanliness requirements. The weight of the tin was constant: 0.03 g. The runs were done under a vacuum of (2-4)$\times$10$^{-3}$ Pa in the temperature range 400-1000°C using the technique of letting a droplet flow over from an inert (zirconium oxide) substrate onto a plate (supplied from above) recording the process using high speed profile motion picture photography [2]. For a quantitative description of the spreading process, we used the contact angle at the three-phase

*Deceased.
Fig. 1. Displacement of the three-phase boundary vs. time in log—log coordinates for spreading of tin on nickel (a), stannides Ni$_3$Sn (b) and Ni$_3$Sn$_2$ (c) at temperatures 400 (1), 500 (2), 600 (3), 700 (4), 800 (5), 900 (6), and 1000°C (7).