V. V. Sagaradze. *Strengthening austenitic nonmagnetic steels by phase hardening.* A process for strengthening metastable austenitic alloys by bringing about direct and reverse ($\gamma-\alpha-\gamma$) martensitic transformations that has come to be known as phase hardening was developed in the late 1950s by K. A. Malyshev, V. D. Sadovskiĭ, and co-workers at the USSR Academy of Sciences Institute of Metal Physics.[1]

The strengthening of austenite as a result of the double martensitic transformation is explained both by partial inheritance of the martensite dislocation structure by the newly formed austenite and by the introduction of new structural imperfections directly during the reverse martensite transformation. Recent studies[2,3] have shown that depending on the conditions during the $\alpha-\gamma$ transition, various structual types of the γ phase (coarse lamellar, fine lamellar, globular) and, accordingly, totally different mechanical properties can be obtained in iron-nickel-base austenitic alloys.

Coarse lamellar austenite forms on accelerated heating, when the $\alpha-\gamma$ transition exhibits all the criteria of the martensitic mechanism. Preferred "restoration" of the original austenite orientation is observed as a result of the $\gamma-\alpha-\gamma$ cyclic transformation. Lowering the heating rate during the $\alpha-\gamma$ transition below a certain critical value (~0.4 deg/min in alloys of iron with 32% nickel) results in the formation of another variety of austenite: extremely fine, variously oriented lamellar γ crystals with a $\{156\}_\alpha$ habitus plane. The yield point of a carbon-free martensite can be increased by a factor of 1.5 on precipitation of these crystals. The third structural form of the γ phase—globular austenite (globule sizes less than 1 μm) forms in iron-nickel alloys during slow heating in the second stage of the $\alpha-\gamma$ transformation.

Types N26KhT1 and N26T3 nonferromagnetic austenitic steels, which can be strengthened by phase hardening and aging, have now been developed; they have higher fatigue limits ($\sigma_{-1} = 60$ kgf/mm^2) than known austenitic steels and can be surface-hardened successfully with formation a wear-resistant martensitic layer of any desired depth. Work is being done on the development of phase-hardenable stainless steels and on iron-manganese-base austenitic steels. The discovery of a new structural variety of austenite—a fine-lamellar phase with $\{156\}_\alpha$ habitus that forms in the $\alpha-\gamma$ transformation with reproduction of the crystallographic orientations of the austenite—will make it possible to advance research toward the creation of new high-strength materials.

[1]N. A. Borodina, V. G. Gorbach, K. A. Malyshev, V. A. Mirmel'shteĭn, and V. D. Sadovskiĭ, in: Uprochenie staleĭ (Hardening of Steels), Metallurgizdat, Sverdlovsk Division, Sverdovsk, 1960, p. 5.
[2]V. V. Sagaradze and Yu. A. Vaseva, Fiz. Met. Metalloved. **42**, 397 (1976).
[3]K. A. Malyshev, V. V. Sagaradze, I. P. Sorokin, N. D. Zemtsova, V. A. Teplov, and A. I. Uvarov, Fazovyi naklep austenitnykh splavov na zhelezo-nikelevoĭ osnove (Phase Hardening of Iron-Nickel Base Austenitic Alloys), Nauka, Moscow, 1982.

V. I. Syutkina. *New hardening mechanisms of ordered alloys.* Modern industry has a great need for alloys with combinations of optimum properties. Development of such alloys is especially difficult. There is much room for improvement of the physicomechanical properties of alloys by using phase transformations, among which atomic ordering occupies a special position, primarily because many properties of the alloy (electrical, thermal, magnetic, mechanical, corrosion, etc.) change simultaneously on establishment of long-range order in the disposition of the various atomic species. This alone can provide a basis for development of alloys with given sets of properties. However, extensive industrial use of ordered alloys is being held up by their unsatisfactory mechanical properties: they are either not strong enough or very brittle.