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Some physical properties and crystallization of Fe-based metallic glasses under thermomechanical treatment

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Magnetic susceptibility and electric resistance of the Fe-based metallic glasses were studied in 300–900 K temperature range under the action of uniaxial mechanical stress σ = 0–1.0 GPa. As a result of thermomechanical treatment of the studied MGs the Curie temperature increases by 6–8 K, this effect being determined mainly by the temperature of treatment rather than the presence of the external mechanical stress. At the same time crystallization temperature T_x significantly changes under the action of deformation. This effect exhibits a non-monotonous behavior. The increase of T_x at low stress is conditioned, presumably, by the decrease of specific volume upon the deformation of ribbons. Temperature dependences of the resistivity for the studied glasses could be well described by the equation of Evans-Greenwood-Lloyd. The dependence of resistance on the level of mechanical stress is controlled not only by the changes of the sample's geometry under deformation but also by the changes of structure factor of glasses. The latter may be expressed in a form similar to the static Debye-Waller factor.

Магнитная восприимчивость и электрическое сопротивление металлических стекол на основе Fe исследованы в температурном интервале 300–900 К при действии одноосного механического напряжения σ = 0–1,0 ГПа. При термомеханической обработке исследованных стекол наблюдается возрастание температуры Кюри на 6–8 К, причем это возрастание определяется, главным образом, температурой обработки, а не наличием внешних механических напряжений. Вместе с тем, температура кристаллизации T_x заметно изменяется под влиянием деформации. Это изменение имеет немонотонный характер. Возрастание T_x при малых нагрузках обусловлено, по-видимому, уменьшением удельного объема при деформации ленты. Температурные зависимости сопротивления исследованных сплавов могут быть хорошо описаны уравнением Эванса-Гринвуда-Ллойда. Зависимость сопротивления от уровня механических напряжений определяется не только изменением при деформации геометрии образца, но и влиянием напряжений на структурный фактор стекол, которое может быть выражено в форме, аналогичной статическому фактору Дебая-Валлера.

Amorphous metallic alloys on the base of iron are known to be widely considered as prospective materials for magnetic circuits, because of unique combination of their service characteristics. In particular, the $Fe_{80}Si_2B_{16}$-based metallic glasses (MG) have initial magnetic permeability $\mu_0 \geq 7000$ at 1 kHz frequency, magnetic losses $P \leq 20$ W/kg, high enough saturation induction (1.2 T) [1] that make them applicable for 0.05–10 kHz frequency region. It is also known that the high level of key service characteristics (for instance, saturation magnetization, initial permeability, magnetic loss) of Fe-Si-B MGs provides the possibilities to use them in different electronic devices [2, 3].

Meanwhile, MGs are non-stable by their nature. The extent of their instability de-