to amorphous SiO_2, also indicates a high crystallinity and phase purity of all samples.

It should be borne in mind that the exact value of the frequency where the group absorbs depends on the environment of this group and its physical state. The first type of oscillation characterizing the primary structural units (Al and Si tetrahedra) refers to the bands in areas of 950–1250 sm^{-1} and 400–500 sm^{-1}. A strong absorption band at 950–1250 sm^{-1} is due to valence oscillations inside tetrahedra (1058.13 and 1067.58 sm^{-1}).Oscillations at 450–650 sm^{-1} are characteristic for bonds Al–O–Si. This determines the topology of the secondary structural units and the structure of the zeolite. It is known that the valence oscillations of Si–O and Al–O in tetrahedra correspond to absorption bands in the range of 650–820 sm^{-1}.The position of these bands depends on the Si/Al ratio in the zeolite framework. The shift of the bands to the low-frequency areas occurs with an increase in the content of tetrahedrally coordinated aluminum cations. According to experiments the ion exchange of the initial cations with magnesium cations does not affect the thermal stability of the Nakhchivan zeolite. As it is known in our studies, the structure of Nakhchivan zeolite is stable up to 960 ^oC. Ion exchange with magnesium cations does not affect the thermal stability, it means that the natural sample after ion exchange is also stable up to 960 ^oC.

We found that the ion exchange of the initial cations with magnesium cations affected the pore volume of the natural sample (silicate module), which can have a serious effect on its adsorption and catalytic properties. As a result of the cation exchange the modified magnesium-substituted zeolite represents a high-silica zeolitewith a high value of the silicate module.

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Direct surface-relief gratings recording using Se layers

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Nanomultilayer structures on the base of chalcogenide glasses attract much attention due to the possibility of direct surface relief recording [1−3]. Photo stimulated processes in amorphous *a*-Se can play important role in surface relief formation in such multilayer nanostructures [2]. The structure of *a*-Se is composed only with–Se−Se− homopolar bonds, which probably form (deformed) rings and entangled chains, the ratio naturally depending upon preparation procedures [4]. When *a*-Se is illuminated structural changes proceed as shown by Raman spectra [2].

The aim of this work was to study direct surface relief formation using Se layers as recording media. Thickness *d* of thermally evaporated Se layers was $d(\mathrm{Se}) = 628 \pm 3$ nm. Optical constants were obtained in 600−900 nm range from transmission data. Obtained value of optical gap Eg_{opt} equaled to 1.92 eV. A DPSS laser 532 nm was used for recording transmission gratings (with a period of 1 μm) in Se film and laser diode 650 nm (1 mW) was used to readout the diffraction efficiency (DE) of recorded grating. Holographic recording of diffraction gratings was carried out using P-P polarization of the recording beams, in which the *E* vector of the light lies parallel to the light incidence plane, with total intensity of both beams ~ 3057 mW/cm^2. The angle between writing beams was fixed at $\theta = 30.7$ °, resulting in a grating period of 1 μm. The recording beams were chopped with 0.7 Hz (pulse-like recording). Diffraction efficiency (DE) was calculated as the ratio of intensity in the first order of diffraction to the total light intensity transmitted at normal incidence through the sample. Dependence of DE (η) in the first order of diffraction (650nm probing wavelength) on the exposure time *t* is shown in Fig. 1. Fabricated grating was studied using AFM microscopy. Fig. 2 shows the AFM image of the grating surface recorded on Se film by pulse recording. It was shown that the interference pattern during holographic recording was encoded on the film surface as the surface relief grating. Relief profile was close to sinusoidal one. Obtained value of grating DE (22 %) and AFM data on relief modulation depth *h/d* (*h*- relief depth, *d* grating period) were compared with calculated DE values for such spatial frequency.

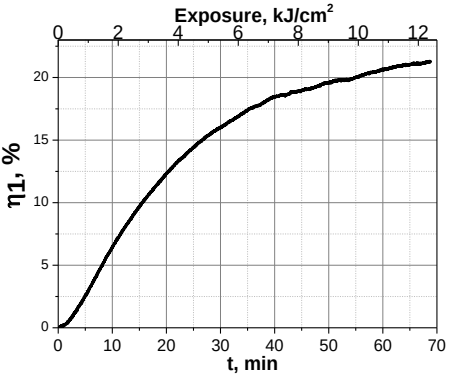

Fig. 1. Dependence of DE in first order of diffraction in transmission mode

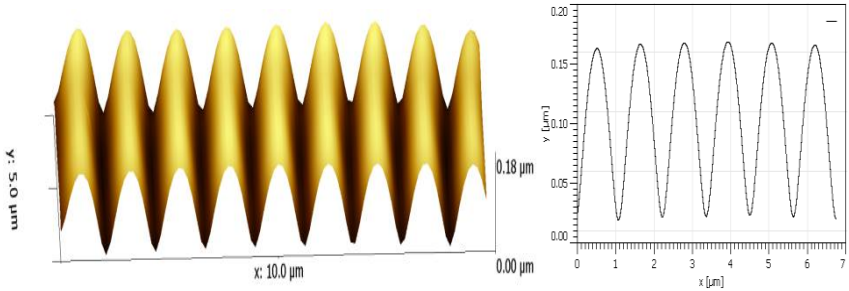

Fig. 2. AFM image of grating and its profile

Thus, pulse-like recording enables to fabricate diffraction gratings with rather high DE values (22 %) in transmission mode using Se layers as recording media. It should be noted that continuous wave (CW) recording at this wavelength does not lead to the formation of surface relief grating. Obtained grating relief depth consisted ~ 140 nm. Good agreement between experimentally obtained DE values and calculated ones was obtained with discrepancy between experimental and calculated values ~ 6 %.

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