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Investigations of thermal properties of simple van der waals crystal based nanocomposites

Physical properties of the objects featuring nanometric linear dimensions have been being intense investigated for over ten years. The reason for the scientific interest is twofold:

• basic science – the objects of dimensions of tens of nanometers display new physical properties, usually very much different than their macroscopic counterparts

• possible applications – the new properties of such the objects make it possible to design new devices. The nanostructured materials along with their new properties utilized as a base for new technologies have recently caused an unprecedented acceleration in some of their fields.

Key words: thermal conductivity, nanopowders, cryocrystals crystal lattice.

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Исследование термических свойств нанокомпозитов на основе простых кристаллов Ван-дер-Ваальса

Относительная простота кристаллографической структуры матрицы и взаимодействия между составляющими делает криокристаллы с внедренными нанопорошками идеальными объектами фундаментальных физических исследований. В настоящей работе представлен экспериментальный метод исследования теплопроводности нанопорошков диэлектриков и металлов со средним диаметров в пределах от 10 до 50 нм, внедренных в кристаллическую решетку неона, аргона, азота и метана. Измерения проводились в температурном диапазоне 1-40 К стационарным методом.

Ключевые слова: теплопроводность, нанопорошки, криокристаллы, кристаллическая решетка.

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Ван-дер-Ваальстің қарпайым кристалдарының негізіндегі нанокомпозиттердің термиялық қасиеттерін зерттеу

Матрицаның крситаллографикалық салыстырмалы түрде қарапайымдылығы және құраушыларының арасындағы өзара байланысы енгізілген криокристалды ноноұнтақтары бар криокристалдарды негізгі физикалық зерттеулердің идеал зерттеу нысаны болуына себеп болады. бұл жұмыста диэлектриктердің және металдардың орташа диаметрі 10-нан 50нм-ге дейін неонның, аргонның, азоттың және метанның кристал торына енгізілген наноұнтақтарының жылуөткізгіштіктерін зерттеудің тәжірибелік әдісі көрсетілген. өлшеулер 1-40К температуралық интервалда тұрақты әдіспен жүргізілді.

Түйін сөздер: жылуөткізгіштік, нанұнтақтар, криокристаллы, кристалдық тор.

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For the similar reason more complex nanostructured materials are also of great interest and therefore are subject to intense investigations.

A particular example of nanostructured material arecryocrystals with nanopowders immersed in their volume. A relative simplicity of crystallographic structure of the matrix and interactions between the constituents make them ideal objects for basic physics investigations. By applying the thermal conductivity experimental technique to investigate such objects one can get an answer to numerous questions regarding the influence of properties and parameters of the components of such nanocomposites on their total thermal conductivity. The results of investigations are going to determine, in particular, the influence of the size of nanoparticles and their intrinsic transport properties on the resultant thermal conductivity of the nanostructured material. The role of the parameters of the crystalline matrix, such as the interaction strength between its atoms (molecules), the atomic (molecular) mass of the constituents or the type of the excited thermal vibrations of the lattice for the thermal conductivity can be specified. Here we present experimental technique which will be used to investigate thermal conductivity of nanopowders of dielectrics and metals of average diameter ranging from 10 to 50nm, embedded in crystalline matrixes of neon, argon, nitrogen and methane. The measurements will be carried out in the temperature range ~1 to 40K with steady-state method.

The preliminary results of the measurements carried out on sample of methane with 30nm nanoparticles of hydroxyapatite embedded in the crystal volume showed a low value of the coefficient at temperatures below 10K, lower than that of amorphous solids. Also some kinks of the dependence of the thermal conductivity coefficient on temperature of unknown origin were noticed.