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IR-Investigation of Glass Transition in Thin Films of CF_3-CFH_2 Cryodeposites

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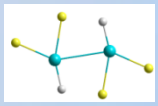
ABSTRACT

On the basis presented results, and our previous obtained data the assumption of presence of structural transformations in cryofilms is made: at a temperature in the vicinity of 72 K, a classical transition takes place the glasss state-supercooled liquid (G-SCL). We believe that the value of the temperature of this glass transition is approximately T_g= 72 K. The temperature range from 75 to 78 K is the area of the quasi-stable SCL existence. At a temperature of about 78 K, crystallization of SCL into the state of an orientationally disordered plastic crystal-OG orientation glass begins. At a temperature T_{trans}=80 K, a quasi-glass transition occurs from the state of the OG orientation glass to a plastic crystal with an ordered rotational subsystem of the PC. In the temperature range 83-85 K, a plastic crystal - monoclinic crystal.

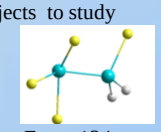
INTRODUCTION

Dynamic glass transition: when the temperature is decreased below a certain point, the relaxation time increases enormously that a dramatic dynamical arrest intervenes and we are unable to equilibrate the system within reasonable experimental times. Once the existence of the liquid is secured against unwanted crystallisation, the temperature can be decreased so much as to meet the dynamic glass transition, (*Tg*) [1]

In the last decade the behavior of thin films such structural transformation of cryocondensates of elementary organic molecules, such as Freons [2] are receiving great attention. Moreover, due to different properties caused by different structure of molecules such as symmetry and asymmetry, these molecules are interesting objects to study



Freon 134



Freon 134a

Research question: what extent do different types of molecular vibrations react to structural transformations in condensed Freon 134a films, and how can this information be used to determine the parameters of these transitions.

EXPERIMENTAL PART

Objects of the research: Freon 134a films (Climalife, Belgium, purity 99.8%)

Preparation: Thin Freon 134a film were obtained by using our institute's standard procedure [3] Deposition temperature (T_{dep}) =16 -100 K, P = 10^{-4} -10^{-6} Torr.

Characterization: thickness of the films (d) = 2.5 μm (was measured by a two-beam laser interferometer).

To determine *Tg* we used IR-spectrometer ICS 20 in the interval 400-4200 cm^{-1}. For continuous monitoring of the position of the absorption band, the value of the observation frequency of the spectrometer at the half-width of the absorption band was fixed and the corresponding thermogram was taken. This gives current information about the changes in the position of the absorption bands of the vibrational spectrum of freon 134a during the thermovariation of the sample under study. In detail, the experimental setup and the measurement technique are described by us in earlier publication [4].

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[3]. Aldiyarov, A.; Aryutkina, M.; Drobyshev, A., Low Temp. Phys. 37 (6), 524 (2011)
[4]. Drobyshev, A.; Abdykalykov, K.; Aldiyarov, A.; Low Temp. Phys. 33 (8), 699 (2007)
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RESULTS

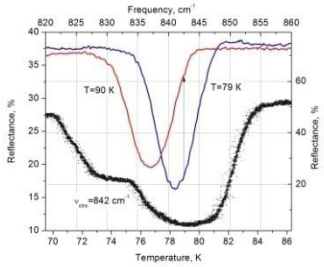

Fig. 1-The thermogram (lower curve) of the Freon 134a molecule.

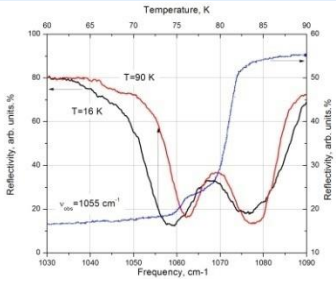

Fig. 2-The thermogram at the observation frequency ν_{obs} = 1055 cm^{-1}.

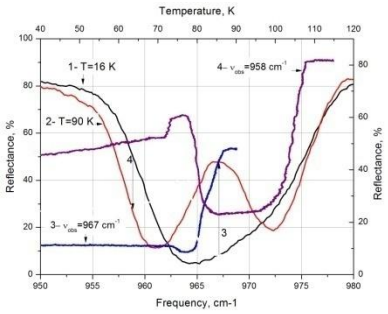

Fig. 3 - Thermally induced changes in the position and nature of the absorption of the ν_{15} mode.

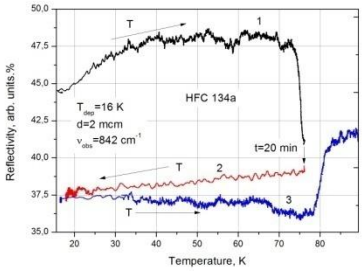

Fig. 4-Thermograms of the change in the position of the absorption band ν_7 during thermal cycling

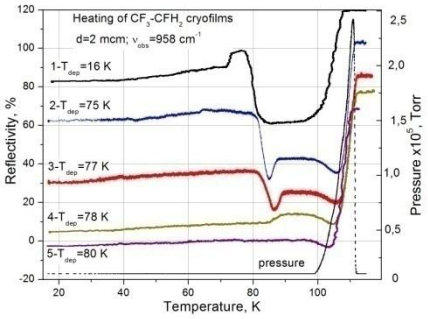

Fig. 5-Thermograms of heating Freon 134a cryofilms, formed at different temperatures.

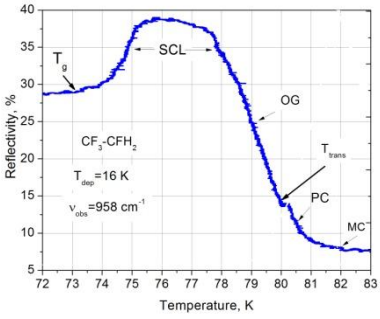

Fig. 6- Enlarged fragment of the thermogram 1 of Fig. 5

CONCLUSIONS

1.The temperature of Freon 134a glass transition is approximately 72 K.

2. The same state can be achieved in completely different ways! Plastic orientationally disordered crystal-plastic crystal, plastic crystal-monoclinic crystal . Or these states are not equivalent, as in the case of Water "A" and Water "B" [5].