CONTROLLED DRUG DELIVERY SYSTEM OF NATURAL/SYNTHETIC SILICA STRUCTURES TO THE DERMIS

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EXTENDED ABSTRACT

The paper is the first communication on an exploratory study of the use of three compounds: bentonite, clinoptilolite and SBA-15 (Santa Barbara Amorphous). The last component, SBA-15, is the cutting-edge result of a chemical synthesis with perspectives for use in the biochemical field, but also as a new controlled delivery system grafted on fibrous textile component for the release a drug from a textile to the dermis. Components are characterized in terms of the specific surface area (m^2/g), pore size and sorption performance in relation to two antibacterial agents: silver sulfadiazine (4-amino-N- (pyrimidinyl) benzenesulfonamide, CAS no. 68-35-9) and silver nanoparticles obtained by reduction from an inorganic salt ($AgNO_3$). Antibacterial agents are used in applications on burn wounds of large surface area and antibacterial bedding fabrics on a cellulosic structure. Subsequently the porous agent which presented maximum efficacy, as adsorption and drug delivery is grafted onto a 100% cotton knitted structure (interlock structure with yarns of Nm = 70/1 fineness). The experiments on kinetics of drug release from textile to solution are made at 37°C and pH = 5.5 according to standard of ISO 105-E04-2008E. The study determines the type of drug sorption isotherm, the zeolite absorption kinetics, the silver sulfadiazine molecular sizes and the in vitro drug delivery kinetics. As well, in the paper one presented the advantages and drawbacks of the delivery system.

Key Words:silica structure, drug delivery, medical textiles

1. INTRODUCTION

Porous clay based nanocomposites (Bentonite, Montmorilonite K10, Clinoptilolite)[1] and mesoporos Silica (SBA-15) [2] are increasingly having more attention from the pharmaceutical industry.

The ability of a biomaterial to adapt, perform controlled action, and be accepted by the surrounding environment without causing adverse reactions [3]is a desideratum for biomaterials that are in direct contact with the skin.

Properties like: porosity, mechanical stability, the possibility of re-use, low cost and last but not least biocompatibility, all of this and mutch more interesting properties brough these products to our attention, that and the fact that the textiles must be biocompatible when they have the intention of a tread at the surface of the wound.

The means used as the diffusion agent of inorganic origin are characterized as the specific surface area (m^2/g), pore size and sorption performance in relation to two antibacterial agents: silver sulfadiazine (4-amino-N- (pyrimidinyl) benzenesulfonamide) and nanoparticles of silver obtained from a silver salt (AgNO3).

2. EXPERIMENTAL PART

2.1. MATERIALS AND METHODS

The clays silver products, and the silver mesoporous Silica were obtained by using ionic exchange method with $AgNO_3$.

2.1.1 IONIC EXCHANGE ON CLAYS

Silver based clays were obtaind by ion exchange of Bentonite, Montmorilonite (K10 FLUKA) and Clinoptilolite, using $AgNO_3$.

The general procedure followed for the preparation of clays samples consisted in the sequence of steps as it follows: one used 1g of clay that has been brought in to contact for 24h at 70^0C, under constant agitation (at 750 rpm) with a aqueous solution of silver nitrate ($AgNO_3$) obtained by dissolving 0.5 g $AgNO_3$ in 50 ml distilled water. The solids were filtered under vacuum and dried at 80^0C for 12h.

2.1.2 IONIC EXCHANGE ON SBA-15

The general procedure followed for the preparation of Ag-AlSBA-15 samples consisted in the sequence of steps described in fig.1 [4]. For start pure siliceous SBA-15, designed in this study as parent material, was provided to us by the Department of Catalysis from the "Gh. Asachi" Technical University of Iasi. The material was calcined in air flow at 550^0C for 8h to obtain a SBA-15 powder. From calcinated SBA-15 silica, the AlSBA-15 were obtained, by grafting with sodium aluminate. Silica SBA-15 (2g) was suspended under stirring in 200ml of aqueous solution containing 0.6g of sodium aluminate for 15h at 25^0C. NaAlSBA-15 that resulted was filtered, washed with distiled water, dried at 80^0C, and calcined for 8 h in air flow at 550^0C. 1g of NaAlSBA-15 obtained was contacted for 24 h at 70^0C, under constant agitation in a aqueous solution of $AgNO_3$ obtained by dissolving 0.5 g $AgNO_3$ in 50 ml of distilled water, this procedure was repeated twice, the sample obtained was filtered under vacuum and dried for 24h at 100°C [4].

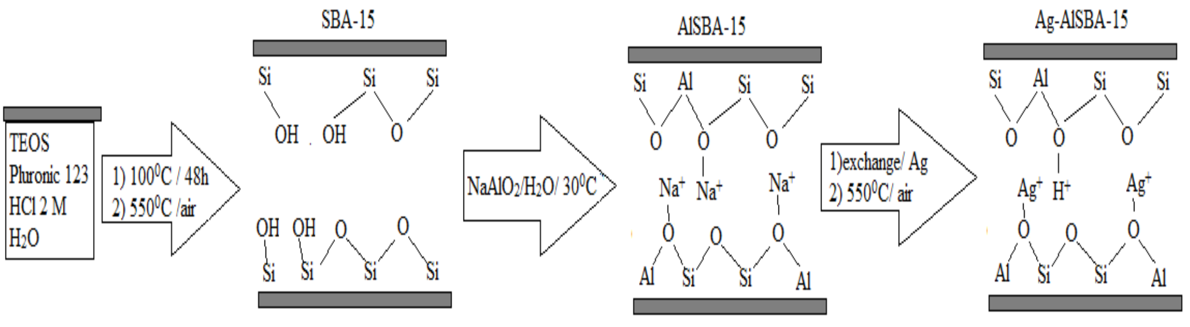

Fig. 1: Procedure of Ag-AlSBA-15 preparation

2.2 CHARACTERIZATION

The specific surface area, S_{BET}, was calculated in the domain of validity of the BET equation. The pore volume have been evaluated from the nitrogen sorbtion isotherm that was performed on TriStar 3000 V6.04 apparatus.

Analyzes will also be made regarding the amount of Ag^+ ions found in the pores of the products as well as other analyzes and determinations, among which we mention the X-ray diffraction and the atomic absorption spectrometry[5] have been made.

3. RESULTS AND DISCUSSIONS

The nitrogen sorption isotherms, offers data on the textural properties of Kniting Cotton as seen in fig.2, on the supports such as: Bentonite, Montmorilonit-K10, Clinoptilolit, SBA-15 which are compared in fig.3, and on the supports enriched with silver ions such as: Ag Bentonite, Ag Montmorilonit-K10, Ag Clinoptilolit, Ag SBA-15 which are compared in fig.4, to draw up a new system of controlled drug release with a higher biocompatibility and availability for larger amounts of drugs.

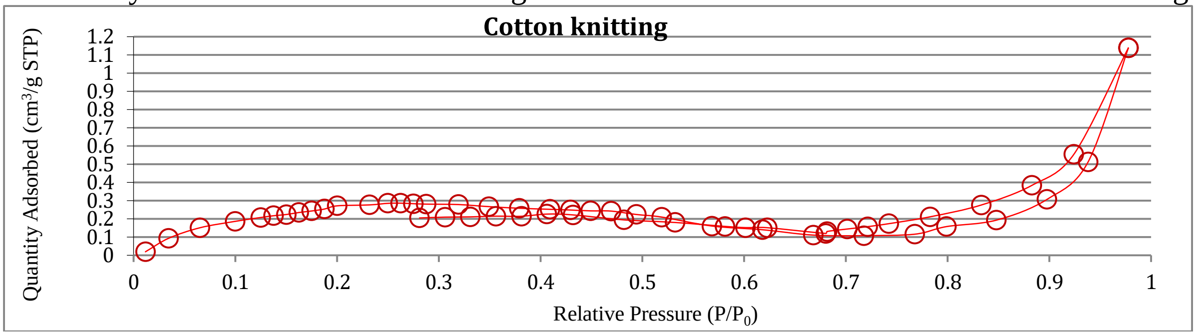

Fig. 2:Cotton knitting Adsorption/ Desorption Isotherms

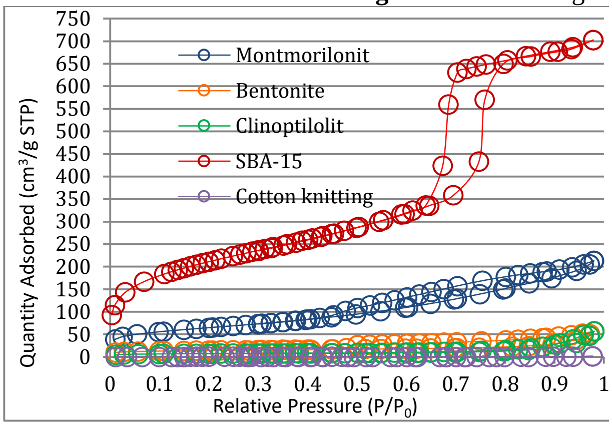

Fig. 3:Comparision of Adsoption/ Desorption Isotherms for supports

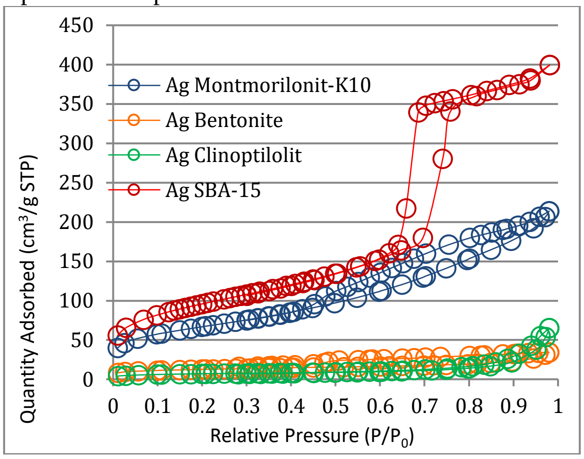

Fig. 4:Comparision of Adsoption/ Desorption Isotherms for supports enriched with silver ions

4. CONCLUSIONS

Biomaterials based on silicates designed for medical textiles, that are used on skin surface can functionally support the reepithelialization of wounds produced by high surface burns.

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