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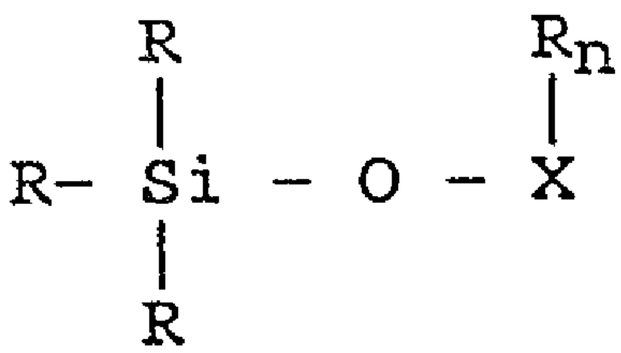
(54) **BOROSILICATES, ALUMINOSILICATES, PHOSPHOSILICATES ET PURIFICATION DE L'ADN**

(54) **BORON SILICATES, ALUMINUM SILICATES, PHOSPHOSILICATES AND PURIFICATION OF DNA**



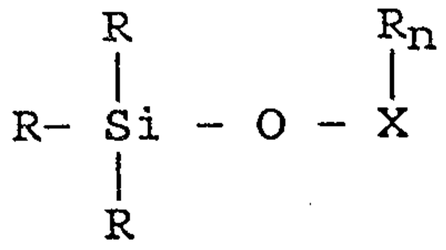
(57) The invention discloses boron silicates, aluminum silicates and phosphosilicates, how to make them, and processes for purifying DNA with them. The new composition is of the formula: (see above formula) wherein X is Silicon, Boron, Aluminum or Phosphorus, and R is independently OH or a monomer unit, n is 3 when X is Si and n is 2 when X is Boron, Aluminum, or Phosphorus, and repeating units of the composition comprising the formula: (see above formula) and compositions comprising the above monomer and repeating units thereof. Repeating units described above can include from about 2 up to infinity. Ranges include about 2 to about 100,000,000, and about 2 to about 100,000.

ABSTRACT

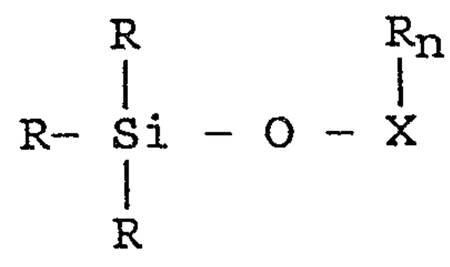
BORON SILICATES, ALUMINUM SILICATES, PHOSPHOSILICATES

PURIFICATION OF DNA

The invention discloses boron silicates, aluminum silicates and phosphosilicates, how to make them, and processes for purifying DNA with them. The new composition is of the formula:



wherein X is Silicon, Boron, Aluminum or Phosphorus, and R is independently OH or a monomer unit, n is 3 when X is Si and n is 2 when X is Boron, Aluminum, or Phosphorus, and repeating units of the composition comprising the formula:



and compositions comprising the above monomer and repeating units thereof. Repeating units described above can include from about 2 up to infinity. Ranges include about 2 to about 100,000,000, and about 2 to about 100,000.

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BORON SILICATES, ALUMINUM SILICATES, PHOSPHOSILICATES AND PURIFICATION OF DNA

FIELD OF THE INVENTION

The invention is in the field of molecular biology. In particular, the invention is in the area of deoxyribonucleic acid purification.

BACKGROUND OF THE INVENTION

The continued advances in molecular biology and related disciplines present continued needs for improvements in tools associated with fully appreciating and developing the advanced technology.

A wide range of technologies involve the use of deoxyribonucleic acids (DNA) in a variety of forms. For example, advances in the area of recombinant DNA technology continually require the use of DNA in the form of probes, genomic DNA, and plasmid DNA.

Advances in the area of diagnostics also continue to utilize DNA in a variety of ways. For example, DNA probes are routinely used in the detection and diagnosis of human pathogens. Likewise, DNA is used in the detection of genetic

disorders. DNA is also used in the detection of food contaminants. And, DNA probes are routinely used in locating, identifying and isolating target DNA of interest for a variety of reasons ranging from genetic mapping to cloning and recombinant expression.

In many instances DNA is available in extremely small amounts, and isolation and purification procedures can be laborious and time consuming. The often time consuming and laborious procedures can lead to loss of DNA. In the purification of DNA from specimens obtained from serum, urine, and bacterial cultures, there is the added risk of contamination and false-positive results.

Typical DNA purification protocols involve the use of caustic and poisonous compositions. The typical DNA purification protocol uses high concentrations of chaotropic salts such as sodium iodine and sodium perchlorate.

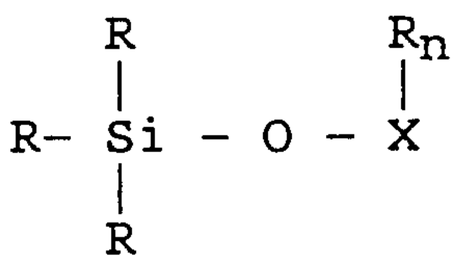
There are numerous protocols for purifying DNA. As evidenced by recent activity in the area of DNA purification, there is a continued pursuit for optimal DNA purification protocols. U. S. Patent 4,923,978 discloses a process for purifying DNA in which a solution of protein and DNA is passed over a hydroxylated support and the protein is bound and the DNA is eluted. U.S. Patent 4,935,342 discloses purification of DNA by selective binding of DNA to anion exchangers and subsequent elution. U. S. Patent 4,946,952 discloses DNA

isolation by precipitation with water-soluble ketones. A DNA purification procedure using chaotropes and dialyzed DNA is disclosed in U. S. Patent 4,900,677.

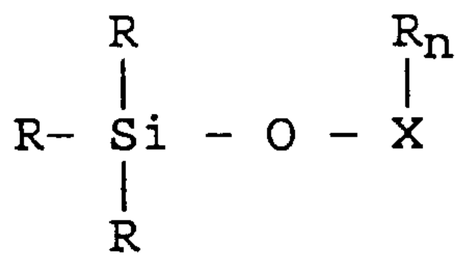
While the present protocols for purifying DNA are able to accomplish their goal, it is desirable to purify DNA without the use of such caustic and poisonous compounds such as the most often used chaotropes in addition to obtaining increased amounts of DNA.

SUMMARY OF THE INVENTION

The invention provides the monomer unit composition:



wherein X is Silicon, Boron, Aluminum or Phosphorus, and R is independently OH or a monomer unit, n is 3 when X is Si and n is 2 when X is Boron, Aluminum, or Phosphorus, and repeating units of the composition comprising the formula:



and compositions comprising the above monomer and repeating units thereof. Repeating units described above can include from about 2 up to infinity. Ranges include about 2 to about 100,000,000, and about 2 to about 100,000.

The invention can be used to purify DNA from a variety of sources and from a variety of forms. The process uses the composition of the invention and renders the use of binding buffers, such as chaotropes, optional. The DNA can be bound in aqueous solution such as TE buffer (10mM Tris, 1mM EDTA) at room temperature. In addition, the DNA can be eluted into water from the compositions of the invention by heating, or generally used elution buffers such as TE or 1 X TAE can be employed. Sources of DNA for purification include bacteria, bacteriophage, specimens, plants, animals, and the like. DNA can be found in a variety of forms and includes single-stranded, double-stranded, circular, and linear. The invention can be practiced with DNA from any source in any form.

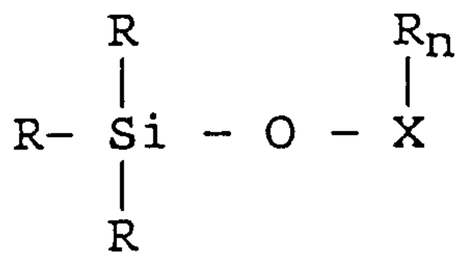
Thus, the present provides in one embodiment a process for purifying DNA which comprises binding the DNA to a DNA binding compound obtainable by a process comprising the steps of: a) preparing a reaction mixture consisting essentially of $SiCl_4$ and a second component selected from the group consisting of: a molar percentage of BCl_3 of about 33.5%, a molar percentage of BCl_3 of about 55.6%,a molar percentage of BCl_3 of about 83.3%, a molar percentage of PCl_3 of about 50.0%-83.3%, and a molar percentage of $AlCl_3$ of about 9.1%; b) cooling the reaction mixture; and c) adding water to the reaction mixture until evolution of gas is complete.

In another embodiment, the invention provides, a kit for purifying DNA, which comprises a binding buffer and a DNA binding compound obtainable by such a process.

In another embodiment of the invention, A DNA binding compound obtainable by a process comprising the steps of: a) preparing a reaction mixture consisting essentially of $SiCl_4$ and a second component selected from the group consisting of: a molar percentage of BCl_3 of about 33.5%, a molar percentage of BCl_3 of about 55.6%, a molar percentage of BCl_3 of about 83.3%, a molar percentage of PCl_3 of about 50.0%-83.3%, and a molar percentage of $AlCl_3$ of about 9.1%; b) cooling the reaction mixture; and c) adding water to the reaction mixture until evolution of gas is complete.

DETAILED DESCRIPTION

The invention provides the monomer unit composition:



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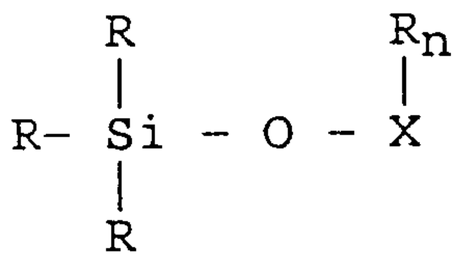
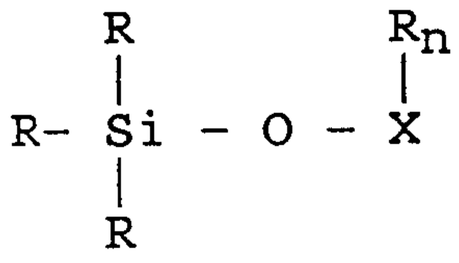
wherein X is Silicon, Boron, Aluminum or Phosphorus, and R is independently OH or a monomer unit, n is 3 when X is Si and n is 2 when X is Boron, Aluminum, or Phosphorus, and repeating units of the composition comprising the formula:



and compositions comprising the above monomer and repeating units thereof. Repeating units described above can include from about 2 up to infinity. Ranges include about 2 to about 100,000,000, and about 2 to about 100,000.

The surface provides for binding of DNA while also allowing easy recovery of DNA from the surface.

Also provided is a process for purifying DNA which comprises contacting DNA with a composition of the formula:



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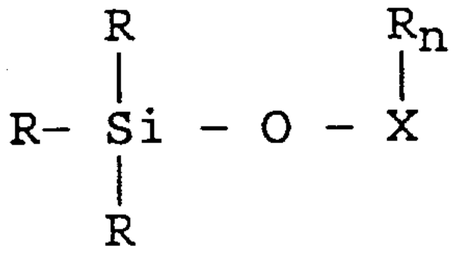
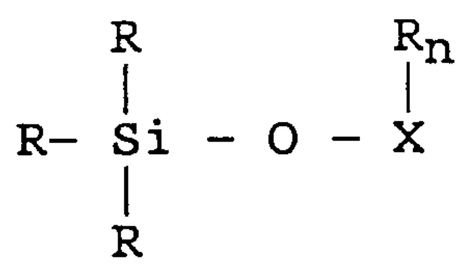


and compositions comprising the above monomer and repeating units thereof. Repeating units described above can include from about 2 up to infinity. Ranges include about 2 to about 100,000,000, and about 2 to about 100,000.

Reaction products of a mixture of $SiCl_4$ and BCl_3, or PCl_3, or $AlCl_3$ followed by the addition of water are also provided.

The invention also provides a method for making the composition of the formula:



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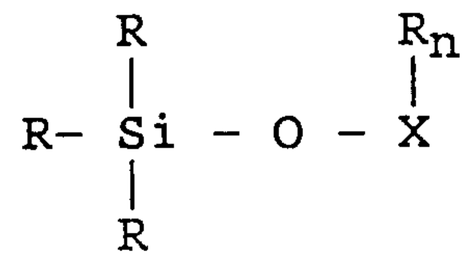

and compositions comprising the above monomer and repeating units thereof. Repeating units described above can include from about 2 up to infinity. Ranges include about 2 to about 100,000,000, and about 2 to about 100,000.

Generally, reaction products of water and a mixture of $SiCl_4$ and PCl_3, or BCl_3 or $AlCl_3$ result in a bead like structure comprising repeating units of the above referenced monomer unit.

It is possible that the electronic nature of this polymer is such that surface modifications can be made that are of a more conventional nature but are changed electronically due to the presence of this polymer being at the center of the bead (making it a more efficient surface for the purposes described in this disclosure). For example, the surface could be modified with $SiCl_4$ followed by hydration which would result in a silanol coating on the surface. The exposure of the repeating unit is what interacts with the DNA, and thus surfaces comprising the repeating unit are also suitable for practicing the invention. Surfaces which can be designed to comprise compositions of the invention include dipstick configurations, tubes, vials, filtration devices, and the like.

The procedure for obtaining the compositions of the invention generally comprises mixing $SiCl_4$ with various amounts of PCl_3, or BCl_3, or $AlCl_3$, followed by cooling. Water is then added until hydrogen chloride gas HCl(g) no longer elutes, then excess water is added to ensure complete reaction of $SiCl_4$ and BCl_3, or $AlCl_3$ or PCl_3. Amounts of reactants are generally 15:1 to 1:15.

This resulting product is stirred for about thirty (30) minutes. The resultant product is filtered then washed and dried. Suitable washing reagents include acetone and the like. The product is now ready for use in purifying DNA.

The invention also provides a process for purifying DNA which comprises contacting DNA with compositions of the invention.

The start of any DNA purification or isolation procedure requires obtaining the desired DNA from its source. Typical protocols for obtaining DNA from specimens such as serum, urine and bacterial cultures are well known and routinely carried out. Likewise, the ability to obtain DNA from genomic libraries and the like are routine. The key to the invention is the ability to purify DNA, once obtained from its source. Typical procedures for obtaining DNA end with a suspension of

the DNA in solution. References include those for isolation of DNA from biological samples, Harding, J.D., Gebeyehu, G., Bebee, R., Simms, D., Ktevan, L., Nucleic Acids Research ,17:6947 (1989), and Marko, M.A., Chipperfield, R., and Birnboim, H.C., Analytical Biochemistry, 121:382 (1982). Procedures for isolation of plasmid DNA can be found in Lutze, L.H., Winegar, R.A., Nucleic Acids Research 20:6150 (1990). Extraction of double-stranded DNA from biological samples can be found in Yamada, O., Matsumoto, T., Nakashima, M., Hagri, S., Kamahora, T., Ueyama, H., Kishi, Y., Uemura H., Kurimura, T., Journal of Virological Methods 27:203 (1990). Most DNA solutions comprise the DNA in a suitable buffer such as TE (Tris-EDTA (10mM:1mM)), TEA (40mm Tris-acetate, 1mm EDTA) buffer, or a lysate.

Once the DNA is obtained in a suitable solution, a binding matrix is typically added to the solution. Generally used binding matrixes are silica in the form of glass or diatoms. However, procedures using silica require high concentrations of chaotropes or alcohols for the DNA to bind to the surfaces. Currently used chaotropes include sodium iodide (NaI), urea, guanidinium Hydrochloride, sodium perchlorate ($NaClO_4$), and potassium bromide (KBr). Chaotropes and alcohols can be toxic, caustic, flamable and/or expensive. The process of the present invention does not require the presence of chaotropes or alcohols for binding to surfaces of the invention. Processes

of the invention bind DNA in an aqueous solution at room temperature and elute the DNA in water at 37°C. However, if desired, chaotropes, alcohols and the like can be used with the process of the invention.

Typical procedures for using the process of the invention include the addition of the composition of the invention to a solution of DNA, which is generally followed by the addition of a binding buffer. At this point, it is advantageous that the process of the invention does not require a binding buffer. The solution can be incubated for a brief period at room temperature. After spinning, the supernatant can be discarded and the pellet washed. The DNA can then be eluted.

The composition of the invention is typically used in weight ranges from about 1:10 to 1:1 composition weight:water. Preferably excess amounts of water are avoided and buffers such as TE can be used in place of water.

Next, a binding buffer is added, if used. After a brief incubation period at room temperature, although a range of about 20° to about 40°C is acceptable, from about 1 to about 20 minutes, preferably about 10 minutes, the container can be spun to obtain a pellet and supernatant fractions. The supernatant is separated and the pellet is washed with a reagent such as ethanol diluted with 50mM Tris. A preferred wash reagent concentration is 80% ethanol. DNA can then be eluted from the compositions of the invention by using elution buffers such as

TE buffer, 1 X TAE buffer, and 1 X TBE buffer. More importantly, the use of elution buffers can be eliminated altogether, and DNA eluted in water by heating. For maximum yields the elution step can be repeated.

The chemical compositions of the invention can be conveniently assembled into a kit. A kit comprising the composition of the invention can include the composition in a container, such as a vial, with a suitable buffer, such as TE buffer and TAE buffer and optionally include a container of a binding buffer such as chaotropes, a container of wash buffer, such as a solution of ethanol diluted with 50mM tris or 1 X TAE, and a container of elution buffer, such as TE buffer, 1 X TAE buffer, and 1 X TBE buffer. Such a kit would allow convenient purification of DNA.

The following examples illustrate the specific embodiments of the invention described in this document. As would be apparent to skilled artisans, various changes and modifications are possible and are contemplated within the scope of the invention described.

EXAMPLES

EXAMPLE 1

The purpose of this experiment is to synthesize 10 boronsilicate polymers. The polymers contain various amounts of boron because incorporation of boron, a less electropositive atom than silicon, into the polymer will change the electronic nature of the surface and may effect its ability to purify DNA from an aqueous sample by solid phase extraction.

Materials

BCl_3 in CH_2Cl_2(1M) (Aldrich, Milwaukee, WI)

$SiCl_4$ (Petrarch*systems, Bristol, PA)

Procedure: 10 experiments were set up the same way except the percentage of BCl_3 was varied as shown below.

	BCl_3		$SiCl_4$	
Surface	µL	mMol	g	mMol
1	1.0	1.0	1.70	10.0
2	2.0	2.0	1.70	10.0
3	5.0	5.0	1.70	10.0
4	7.0	7.0	1.70	10.0
5	10.0	10.0	1.70	10.0
			µL	mMol
6	5.0	5.0	123.0	1.0
7	5.0	5.0	247.0	2.0
8	5.0	5.0	370.0	3.0
9	5.0	5.0	493.0	4.0
10	5.0	5.0	0.0	0.0

* Trademark

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The $SiCl_4$ and BCl_3 are mixed and cooled to about 5°C for 20 minutes. With stirring, H_2O is slowly added until HCl(g) no longer elutes. 5mL excess H_2O is added to ensure complete reaction. Stirred 1 hour.

Filter, wash 3X10 mL H_2O then 3X10mL acetone, air dry 25 minutes and heat dry 1 hour.

EXAMPLE 2

Phosphorus has approximately the same electronegativity as Boron. Boronsilicates have been shown to work very well for DNA purification. Therefore, if polarization of the surface is important in DNA adhesion/elution then Phosphosilicates should work as well as boronsilicates for DNA purification.

Materials:

$SiCl_4$ (Petrarch Systems)

PCl_3 - 2M in CH_2Cl_2 (Aldrich)

10 experiments were done exactly the same way except that the amount of PCl_3 was different in each experiment. The following table describes each of the 10 experiments.

Experiment	$SiCl_4$ mL	$SiCl_4$ mMol	PCl_3 cq	PCl_3 mL	PCl_3 mMol
1	1.340	10.0	0.1	0.5	1.0
2	1.340	10.0	0.3	1.5	3.0
3	1.340	10.0	0.5	2.5	5.0
4	1.340	10.0	0.7	3.5	7.0
5	1.340	10.0	1.0	5.0	10.0
6	0.65	5.0	1.5	3.75	7.5
7	0.65	5.0	2.0	5.0	10.0
8	0.65	5.0	3.0	7.5	15.0
9	0.65	5.0	4.0	10.0	20.0
10	0.65	5.0	5.0	12.5	25.0

In the typical experiment, the $SiCl_4$ is added to a 25 mL erlenmeyer flask and cooled to 0°C in an ice bath for about 10 minutes. The PCl_3 is then added, cool for 5 minutes. H_2O was added very slowly, about 2 drops per minute, until white gas no longer elutes. Stir 5 minutes and add 3mL in 1mL increments. Stir at room temperature for 15 minutes. Filter, wash the solid with 3X10 mL H_2O then 3*10 mL acetone. Air dry 15 minutes, heat dry one (1) hour. Store in a desicator.

EXAMPLE 3

The purpose of the following experiment is to synthesize aluminum silicate polymers containing various amounts of aluminum. Aluminum is more electropositive than

silicon and, therefore, as the amount of aluminum in the polymer increases so should the amount of DNA adhering to that polymer.

Starting Materials

$AlCl_3$, 1M in nitrobenzene (Aldrich)

$SiCl_4$ (Petrarch System)

Procedure

8 experiments were performed the same way except that the amount of $AlCl_3$ was varied from one to the next.

	$SiCl_4$		$AlCl_3$	
Experiment	mL	mMol	mL	mMol
1	1.34	10.0	1.0	1.0
2	1.34	10.0	3.0	3.0
3	1.34	10.0	5.0	5.0
4	1.34	10.0	7.0	7.0
5	1.34	10.0	10.0	10.0
6	0.67	5.0	7.5	7.5
7	0.67	5.0	10.0	10.0
8	0.67	5.0	15.0	15.0

In a typical experiment the $AlCl_3$ and $SiCl_4$ are mixed together and cooled in an ice bath for 15 minutes. Water is added dropwise, with vigorous stirring. Very slowly (5 drops every 2 minutes), water is added until no HCl(g) elutes from the reaction vessel.

Add about 3 mL H_2O to ensure complete reaction. Stir at room temperature for 15 minutes.

Filter, wash 3X10 mL acetone, 3X20 mL H_2O, 3X10 mL acetone. Air dry for 20 minutes, heat dry one (1) hour. Store in a dessicator.

EXAMPLE 4

This experiment describes how the DNA binding capacity of SUPER FINE SUPER FLOSS CELITE*(the industry standard, Manville) was determined and what that capacity is. It was determined that SUPER FINE SUPER FLOSS CELITE strongly binds and elutes DNA at 2.5M with $NaClO_4$ as the binding buffer.

Materials:

Super Fine Super Floss (SFSF) (Sample from Manville, Denver, CO (1:5 w/w in H_2O))

λDNA (BRL Cat. 56125A)

50mM Tris pH7.0 (Dilute from 1M stock) BRL Cat. 5505UA

(PREP-A-GENE*KIT (Bio-Rad*, Richmond, CA))

Binding Buffers (Diluted from 6M stock) $NaClO_4$ Fisher Cat. 5490-500

Wash Buffer 80% Ethanol in 50mM Tris, pH7.0

Elution Buffer

Milli Q*H_2O

Ethidium Bromide (10mg/ml) Sigma Cat. E-8751

1% agarose BRL Cat. 5510UA

1X TAE (from 50X stock) Tris Base-Sigma CAT T-1503

Acetic Acid - Fisher A38-500

EDTA - Sigma CAT ED2550

* Trademarks

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Type II Loading Dye (25% Ficoll 400, 0.25% Bromophenol Blue, 0.25% xylene cyanol Ficoll* 400 - Sigma* CAT F4375, Bromophenol Blue - BIO-RAD* CAT 161-0404

Xylene Cyanole*- Sigma CAT X-4126

Type 57 and 55 POLAROID* Film

METHODS

1. Two groups of reactions are set up, one for each surface type. Each surface has 8 tubes containing 50µl of the DNA solution. This solution is 0.5µl λDNA in 50µl 50mM Tris, pH7.0 for 31µg DNA/reaction. The titration ranges from 0M $NaClO_4$ to 6M $NaClO_4$.
2. Add 20µl of each surface to the reaction mixes.
3. Add 400µl Binding Buffer according to the titration. For Prep-A-Gene* this was 0.0M, 2.0M, 2.5M, 3.0M, 3.5M, 4.0M, 4.5M, and 6.0M $NaClO_4$. For SFSF, the titration is 0M, 1.0M, 1.5M, 2.0M, 2.5M, 3.0M, 3.5M, and 4.0M $NaClO_4$.
4. Incubate for 10 minutes, with rocking, at room temperature.
5. Spin and discard supernatant.
6. Wash pellet 2 times with 80% ethanol/50mM Tris, pH7.0.
7. Elute DNA in 20µl H_2O, 37°C, 10 minutes.

* Trademarks

8. Spin and remove supernatant to a separate tube. Repeat elution step and combine supernatants for ~40µl total.

9. Add 2µl, Type II loading dye to each tube.

10. Load onto a 1% agarose, 1 X TAE gel. Run for ~25 minutes at 100-130 volts in 1 X TAE buffer.

11. Stain with ethidium bromide in H_2O (~1:1000) for ~15 minutes. Destain for ~20-30 minutes.

12. Photograph over UV light with Type 57 Polaroid film. If possible, take negatives with Type 55 film.

Results and Conclusions

Prep-A-Gene shows no elution of DNA until 3.0M $NaClO_4$, whereas SFSF binds DNA in its native state and elutes strongly at 2.5M $NAClO_4$. Clearly SFSF performs better than Prep-A-Gene.

EXAMPLE 5

This experiment describes the DNA binding capacity of boron silicates, phosphosilicates, and aluminum silicates.

Electrophoresis shows that many of these surfaces give good recovery of DNA down to 1M $NaClO_4$ as the binding buffer. This exceeds the Super Fine Super Floss Celite which gives good recovery only down to 2.5M $NaClO_4$. It would also appear from

gel electrophoresis analysis that some of these surfaces give equal or greater recovery of DNA down to these lower levels of $NaClO_4$ as the binding buffer, and under native conditions.

Materials

Material of composition described for Boronsilicates in substantial accordance with examples 1, 2, and 3.

Phosphosilicates or aluminum silicates.

SUPER FINE SUPER FLOSS (Manville) 1:5 weight:water

Methods

Eight reaction groups are tested for each surface shown below. The binding buffer concentrations are 1.0M, 1.5M, 2.0M, 2.5M, 3.0M, 3.5M, 4.0M with SFSF at 3.0M $NaClO_4$ as the standard used. See Example 4 for procedure.

Results

Table 1 - Results of DNA Binding Studies

Surface	Molar percentage of BCl_3, $AlCl_3$ or PCl_3 in the mixture reaction	DNA Binding 1M-4M [NaC104]	Binding in water
1	9.1	++ 1.5M	
2	16.6	–	
3	33.5	+++	Yes
4	42.2	++ 1.5M	
5	50.0	-	
6	55.6	+++	Yes
7	62.5	++ 1.5M	
8	71.4	++ 2.0M	
9	83.3	+++	Yes
10	9.1	-	
11	16.6	++ 1.5M	
12	33.3	++ 1.5M	
13	42.2	+	
14	50.0	+++	Yes
15	62.5	+++	Yes
16	66.6	++	
17	75.0	+++	Yes
18	80.0	+++	Yes
19	83.3	+++	Yes
20	9.1	+++	Yes
21	23.1	+	
22	33.3	+	
23	41.2	-	
24	50.0	-	
25	60.8	-	
26	66.6	-	
27	75.0	-	

A

- if DNA binding occurred, the DNA didn't elute off.
+ Trace amounts of DNA elute across the titration.
++ Near complete elution down to the indicated Molarity of binding buffer
+++ Strong elution of DNA across the titration

+, ++, and +++ were determined by visualization of ethidium bromide stained gel.

1-9	boron silicates
10-19	phosphosilicates
20-27	aluminium silicates

Conclusion

Several surfaces out-perform SFSF Celite both in the amount of DNA recovered from solution and the concentration of binding buffer required to bring about this recovery. According to agarose gel electrophorsis analysis, near 100% recovery of DNA from solution even to 1.0M $NaClO_4$ as the binding buffer were achieved, with several of the surfaces.

Although the invention has been described with respect to specific modifications, the details thereof are not to be construed as limitations, for it will be apparent that various equivalents change and modifications may be resorted to without departing from the spirit and scope thereof, and it is understood that such equivalent embodiments are to be included therein.

A

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A process for purifying DNA which comprises binding the DNA to a DNA binding compound obtainable by a process comprising the steps of:

a) preparing a reaction mixture consisting essentially of $SiCl_4$ and a second component selected from the group consisting of:

- a molar percentage of BCl_3 of about 33.5%,
- a molar percentage of BCl_3 of about 55.6%,
- a molar percentage of BCl_3 of about 83.3%,
- a molar percentage of PCl_3 of about 50.0%-83.3%, and
- a molar percentage of $AlCl_3$ of about 9.1%;

b) cooling the reaction mixture; and

c) adding water to the reaction mixture until evolution of gas is complete.

2. The process of claim 1, in which DNA is bound to the DNA binding compounds in the presence of an aqueous solution.

3. The process of claim 1, which further comprises elution of DNA from the DNA binding compounds.

4. The process of claim 3, in which elution of DNA is obtained by heat and water.

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5. A kit for purifying DNA, which comprises a binding buffer and a DNA binding compound obtainable by a process comprising the steps of:

a) preparing a reaction mixture consisting essentially of $SiCl_4$ and a second component selected from the group consisting of:

- a molar percentage of BCl_3 of about 33.5%,
- a molar percentage of BCl_3 of about 55.6%,
- a molar percentage of BCl_3 of about 83.3%,
- a molar percentage of PCl_3 of about 50.0%-83.3%, and
- a molar percentage of $AlCl_3$ of about 9.1%,

b) cooling the reaction mixture; and

c) adding water to the reaction mixture until evolution of gas is complete.

6. The kit of claim 5, further comprising a wash buffer.

7. The kit of claim 6, further comprising an elution buffer.

8. A DNA binding compound obtainable by a process comprising the steps of:

a) preparing a reaction mixture consisting essentially of $SiCl_4$ and a second component selected from the group consisting of:

- a molar percentage of BCl_3 of about 33.5%
- a molar percentage of BCl_3 of about 55.6%,
- a molar percentage of BCl_3 of about 83.3%,

C

- a molar percentage of PCl_3 of about 50.0%-83.3%, and
- a molar percentage of $AlCl_3$ of about 9.1%;

b) cooling the reaction mixture; and

c) adding water to the reaction mixture until evolution of gas is complete.

B