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**Datasheet for the decision  
of 1 February 2011**

**Case Number:** T 1516/07 - 3.4.03

**Application Number:** 05251771.1

**Publication Number:** 1583146

**IPC:** H01L 23/485

**Language of the proceedings:** EN

**Title of invention:**

High density nanostructured interconnection

**Applicant:**

LUCENT TECHNOLOGIES INC.

**Opponent:**

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**Headword:**

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**Relevant legal provisions:**

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**Relevant legal provisions (EPC 1973):**

EPC Art. 83, 54

**Keyword:**

"Main and auxiliary request: novelty (denied)"

"Use of capillary forces: not sufficiently disclosed"

**Decisions cited:**

-

**Catchword:**

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Case Number: T 1516/07 - 3.4.03

**D E C I S I O N**  
of the Technical Board of Appeal 3.4.03  
of 1 February 2011

**Appellant:** LUCENT TECHNOLOGIES, INC.  
600 Mountain Avenue  
Murray Hill, NJ 07974-0636 (US)

**Representative:** Sarup, David Alexander  
Alcatel-Lucent Telecom Limited  
Unit 18, Core 3, Workzone  
Innova Business Park  
Electric Avenue  
Enfield EN3 7XU (GB)

**Decision under appeal:** Decision of the Examining Division of the  
European Patent Office posted 26 March 2007  
refusing European patent application  
No. 05251771.1 pursuant to Article 97(1) EPC  
1973.

**Composition of the Board:**

**Chairman:** G. Eliasson  
**Members:** V. L. P. Frank  
T. Bokor

## Summary of Facts and Submissions

- I. This is an appeal from the refusal of application 05 251 771 for the reason that the interconnection of claim 1 was not new (Article 54 EPC).
- II. As announced with the letter dated 24 December 2010 the appellant applicant was not represented at the oral proceedings before the board. The proceedings were held in the absence of the appellant pursuant to Rule 115(2) EPC and Article 15(3) RPBA.

The appellant requested in writing that the decision under appeal be set aside and that a patent be granted on the basis of claims 1 to 8 filed as main (primary) request, or in the alternative, on the basis of claims 1 to 8 filed as auxiliary request, both filed with the grounds of appeal dated 26 July 2007.

- III. Claim 1 of the primary request reads (the differences with respect to the independent claim of the main request refused by the examining division was highlighted by the board):

"1. An interconnection for use with electrical components interconnecting a first (601) and second (603) surface comprising:  
a first surface;  
a second surface;  
a plurality of nanostructures (602) disposed on at least one of said first surface and said second surface, said plurality of nanostructures configured to attach said first surface and said second surface using ~~attractive~~ **capillary or**

**intermolecular** forces and in a way such that said nanostructures form at least a first conductive connection between said first surface and said second surface."

Claim 1 of the auxiliary request reads:

"1. An interconnection for use with electrical components interconnecting a first (601) and second (603) surface comprising:  
a first surface;  
a second surface;  
a plurality of nanostructures (602) disposed on at least one of said first surface and said second surface, **wherein a diameter, pitch, density or any combination thereof of** said plurality of nanostructures **are** configured to attach said first surface and said second surface using **attractive capillary or intermolecular** forces and in a way such that said nanostructures form at least a first conductive connection between said first surface and said second surface."

Both claim requests comprise independent claim 4 directed to an interconnection for use with electrical components in which an intermediate layer having respective pluralities of nanostructures provided at each side of said layer is located between the first and second surface so that the pluralities of nanostructures adhere to these surfaces by capillary or intermolecular forces.

IV. The following document is cited in this decision:

D4 = US 6 297 063 B

V. The appellant applicant argued in writing essentially as follows:

- Capillary forces, much the same as intermolecular forces, do exist between the claimed nanostructures sufficient to attach the first and second surfaces. Moreover, those skilled in the art of nanostructures, particularly nanostructures experiencing the "gecko effect", would understand the existence of capillary or intermolecular forces. Accordingly, one skilled in the art, given the disclosure, would be able to carry out the claimed invention.
- The claims defined "attractive forces" as capillary or intermolecular forces. The plurality of nanostructures attached thus the first and second surface using capillary or intermolecular forces. Furthermore, the claims required that the "attractive forces" attached the first and second surface, as opposed to another feature that might attach the first surface and second surface.
- Reference D4 disclosed that spacers were used to space and hold together the first and second surface, while Van der Waals forces between the nanostructures created an electrical connection there between. Accordingly, it was not the Van der Waals forces which held the surfaces together, but the spacers. Moreover, if any capillary or intermolecular forces existed between the

nanostructures and the surface, they were not sufficient to attach the first and second surfaces. If they were, there would be no need for the spacers.

## Reasons for the Decision

1. The appeal is admissible.
2. *Main (primary) request*
  - 2.1 Claim 1 of this request states that "*said plurality of nanostructures [are] configured to attach said first and said second surface using capillary **or** intermolecular forces*". The claim thus comprises as one embodiment that the two surfaces are attached only by capillary forces and as another embodiment that they are attached only by intermolecular forces. In the following both embodiments will be discussed separately.
  - 2.2 Capillary forces
    - 2.2.1 The description discloses that "*This connection, illustrated in FIG. 6B, is cause (sic) by capillary **and** intermolecular attractions between the molecules of the nanostructure 602 and the molecules of the illustrative substrate 603*" (page 8, lines 4 to 6).
    - 2.2.2 Capillary forces are usually associated with liquids (or fluids in general) in contact with solids and result from the combination of surface tension and the adhesive force between fluid and container. As mentioned previously, the present application does not disclose that capillary forces alone attach the two

surfaces together, but that it is the conjoint action of capillary and intermolecular forces. There is no indication in the application as originally filed how such an attachment can be obtained by capillary forces alone.

2.2.3 Absent any explanations or evidence from the appellant, the board is not persuaded by the statement of the appellant that the skilled person *"would understand the existence of capillary or intermolecular forces. Accordingly, one skilled in the art, given the disclosure, would be able to carry out the claimed invention"*.

2.2.4 The board concludes for these reasons that the use of a plurality of nanostructures to attach a first and a second surface **using capillary forces** has not been disclosed in the application as originally filed in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art (Article 83 EPC 1973).

2.3 Intermolecular forces

2.3.1 The description defines intermolecular forces as comprising Van der Waals forces (page 8, lines 12 to 16).

2.3.2 Document D4 discloses an interconnection for use with electrical components using a plurality of nanowires (column 1, lines 18 to 22; column 6, line 15 to column 7, line 3; Figures 4 and 5). A first and a second plurality of nanowires 14 are respectively provided on a first and a second surface 10, 10'

(Figure 5A; column 6, lines 48 to 51). As the nanowires attach to each other through Van der Waals forces (Figure 5B; column 6, lines 58 to 61), the first and second surfaces are attached by Van der Waals forces as specified in claim 1.

2.3.3 The appellant argued that the presence in D4 of the spacers 17 showed that the surfaces were held together by the spacers while the nanowires merely provided an electrical connection between them.

2.3.4 The board is however not persuaded by this argument, as D4 discloses that the spacers 17 are optional ("can be used") (column 4, lines 60 - 63 and column 5, line 59). In D4, the spacers hold both surfaces in position while the nanowires are grown *in situ* (column 4, lines 17 - 18 and). This is necessary in the embodiments of D4 shown in Figures 1 to 3 where the nanowires grow under the presence of an electric field so that they meet and merge together, forming a rigid electric interconnection (column 5, lines 15 to 27). However, in the embodiment shown in Figures 4 and 5 the nanowires grow on each substrate's surface separately and do not merge (column 4, lines 19 to 28 and lines 48 to 51). Under these circumstances the spacers 17 have the purpose that the nanowires are not crushed when the substrates are brought together, ie they serve to space apart the substrates, not to hold them together. Moreover, as already pointed out in the examining division's decision, "*the presence of ... any other support structure that gives additional mechanical strength to the connections made with the nanostructure, is by no means excluded in claim 1*" (grounds for the decision, point [4], 3<sup>rd</sup> paragraph).



2.3.5 The board therefore judges that the interconnection of claim 1 of the primary (main) request is not new (Article 54 EPC 1973).

3. *Auxiliary request*

3.1 Claim 1 of this request differs from claim 1 of the primary request in that it specifies that "*a diameter, pitch, density or any combination thereof of said plurality of nanostructures are configured to attach said first surface and said second surface using capillary or intermolecular forces*".

3.2 The use of capillary forces was already discussed in relation to claim 1 of the primary request (point 2.2). The same conclusions apply to claim 1 of this request (Article 83 EPC 1973).

3.3 In relation to the use of intermolecular forces, the board considers that in document D4 the nanowires are spaced apart at a pitch and at a density that allows them to touch and attach to each other. The board is unable to recognize how, on the basis of the disclosure of D4, this could not be so.

3.4 The board judges, for these reasons, that the interconnection of claim 1 of the auxiliary request is not new (Article 54 EPC 1973).

4. It follows from the above that both claim requests are not allowable.

**Order**

**For these reasons it is decided that:**

The appeal is dismissed.

Registrar

Chair

S. Sánchez Chiquero

G. Eliasson