Claims

1. Catalytic system based at least:
   - on a preformation conjugated diene monomer,
   - on a metallocene of formula (I),
   - on an organometallic compound as cocatalyst,

$$\{P(Cp^1)(Cp^2)Y\} \qquad (I)$$

   - Y denoting a group comprising a metal atom which is a rare earth metal,
   - Cp^1 and Cp^2, which are identical or different, being selected from the group consisting of fluorenyl groups, cyclopentadienyl groups and indenyl groups, the groups being substituted or unsubstituted,
   - P being a group bridging the two Cp^1 and Cp^2 groups and comprising a silicon or carbon atom.

2. Catalytic system according to Claim 1, in which the cocatalyst is an organomagnesium compound, preferably a diorganomagnesium compound.

3. Catalytic system according to any one of Claims 1 to 2, in which the cocatalyst is a dialkylmagnesium compound or an alkylmagnesium halide, preferably butyloctylmagnesium or butylmagnesium chloride, more preferably butyloctylmagnesium.

4. Catalytic system according to any one of Claims 1 to 3, in which Cp^1 and Cp^2 are identical and are selected from the group consisting of substituted fluorenyl groups and the unsubstituted fluorenyl group of formula $C_{13}H_8$.

5. Catalytic system according to any one of Claims 1 to 4, in which the symbol Y represents the group Met-G, with Met denoting a metal atom which is a rare earth metal and G denoting a group comprising the borohydride BH_4 unit or denoting a halogen atom X selected from the group consisting of chlorine, fluorine, bromine and iodine.

6. Catalytic system according to any one of Claims 1 to 5, in which the rare earth metal is a lanthanide, the atomic number of which varies from 57 to 71.

7. Catalytic system according to any one of Claims 1 to 6, in which the rare earth metal is neodymium, Nd.

8. Catalytic system according to any one of Claims 1 to 7, in which the bridge P corresponds to the formula ZR^1R^2, Z representing a silicon or carbon atom and R^1 and R^2, which are identical or different, each representing an alkyl group comprising from 1 to 20 carbon atoms, preferably a methyl.

9. Catalytic system according to Claim 8, in which Z is Si.

10. Catalytic system according to any one of Claims 1 to 9, in which the metallocene is the (dimethylsilyl)bisfluorenylneodymium borohydride of formula (III):

$$[Me_2Si(Flu)_2Nd(\mu\text{-}BH_4)_2Li(THF)] \qquad (III)$$

Flu representing the $C_{13}H_8$ group.

11. Catalytic system according to any one of Claims 1 to 10, in which the preformation conjugated diene monomer is a 1,3-diene.

12. Catalytic system according to Claim 11, in which the preformation conjugated diene monomer is 1,3-butadiene.

13. Catalytic system according to any one of Claims 1 to 12, in which the molar ratio of the preformation conjugated diene monomer to the metal of the metallocene has a value ranging from 5 to 1000, preferably from 10 to 500.

14. Catalytic system according to any one of Claims 1 to 13, in which the molar ratio of cocatalyst to the metal of the metallocene has a value ranging from 0.5 to 20, preferably from 1 to 10.

15. Process for the preparation of a catalytic system defined in any one of Claims 1 to 14, which comprises the following stages a) and b):
    - a) reacting, in a hydrocarbon solvent, the cocatalyst and the metallocene,
    - b) reacting the preformation conjugated diene monomer with the reaction product from stage a).

16. Process according to Claim 15, in which stage a) takes place at a temperature ranging from 20°C to 80°C and stage b) is carried out at a temperature ranging from 40°C to 100°C, preferably from 60°C to 90°C.

17. Process for the preparation of a polymer which comprises the polymerization of a monomer M in the presence of a catalytic system defined in any one of Claims 1 to 14.

18. Process according to Claim 17, in which the monomer M is selected from the group of the monomers consisting of conjugated dienes, ethylene, α-monoolefins and their mixtures.

19. Process according to Claim 17, in which the monomer M is a 1,3-diene, preferably 1,3-butadiene, isoprene or their mixture.

20. Process according to Claim 17, in which the monomer M is 1,3-butadiene or a mixture of 1,3-butadiene and ethylene.