particles result in neighboring particles having their main axis parallel to each other and to the magnetic field, while their minor axis in the plane of the pigment particles is not, or much less constrained by the applied magnetic field.

[006] With the aim of producing coatings or layers comprising bi-axially oriented magnetic or magnetizable pigment particles, methods for generating time-dependent, direction-variable magnetic fields of sufficient intensity have been developed thus allowing the bis-axial orientation of magnetic or magnetizable pigment particles.

[007] WO 2015/086257 A1 discloses an improved method for producing an optical effect layer (OEL) on a substrate, said process comprising two magnetic orientation steps, said steps consisting of i) exposing a coating composition comprising platelet-shaped magnetic or magnetisable pigment particles to a dynamic, i.e. direction changing, magnetic field of a first magnetic-field-generating device so as to bi-axially orient at least a part of the platelet-shaped magnetic or magnetisable pigment particles and ii) exposing the coating composition to a static magnetic field of a second magnetic-field-generating device, thereby mono-axially re-orienting at least a part of the platelet-shaped magnetic or magnetisable pigment particles according to a design transferred by said second magnetic-field-generating device. Whereas the method disclosed in WO 2015/086257 A1 allows the production of optical effects layers exhibiting improved brightness and contrast compared to the prior art, said process requires two independent steps, wherein the first step requires additional space for the pre-alignment of the magnetic or magnetizable pigment particles. This requirement is cumbersome to be implemented in a high-speed industrial printing equipment since it requires additional space which is not easily accessible on currently printing equipments thus leading to the adaptation of the currently available used equipments and high costs.

US 20170305184 A1 relates to the field of devices and processes for producing optical effect layer (OEL) comprising magnetically bi-axially oriented platelet-shaped magnetic or magnetizable pigment particles. The method described in US 20170305184 A1 relies on a dynamic field component providing a static field in an XY plane and an alternative magnetic field in a Z-direction, which is a complex process resulting in a higher cost.

US 20170253070 A1 provides a method for freezing the orientation of orientable magnetic or magnetizable pigment particles by irradiation to harden the coating layer comprising the orientable magnetic or magnetizable pigment particles through the substrate carrying the coating layer. US 20170001216 A1 describes a system and method for curing flakes by providing a scanning laser which scans across a moving coated substrate in a magnetic field, allowing images to be formed as magnetically aligned flakes are cured into a fixed position. Both US 20170253070 A1 and US 20170001216 A1 are directed towards overlying different optical effects within the substrate requiring a partial curing of the substrate to conserve initial and intermittent optical effects.

[008] Therefore, a need remains for improved processes for producing optical effect layers (OELs), said methods being mechanically robust, easy to implement with an industrial high-speed printing equipment, in particular rotating magnetic orienting cylinders, without resorting to cumbersome, tedious and expensive modifications of said equipment.

SUMMARY OF THE INVENTION

[009] Accordingly, it is an object of the present invention to overcome the deficiencies of the prior art. This is achieved by the provision of a process for producing an optical effect layer (OEL) on a substrate (x10), said process comprising the steps of:

a) applying onto a substrate (x10) surface a coating composition comprising platelet-shaped magnetic or magnetizable pigment particles so as to form a coating layer (x20) on said substrate (x10), said coating composition being in a first state,

b) placing the substrate (x10) carrying the coating layer (x20) on a first magnetic-field-generating device (x30) providing a first magnetic field vector component, said first magnetic-field-generating device (x30) being mounted on a transferring device (TD) thereby subjecting the platelet-shaped magnetic or magnetisable pigment particles to said first magnetic field vector component,

concomitantly moving said substrate (x10) carrying the coating layer (x20) and said first magnetic-field-generating device (x30) in the vicinity of a static second magnetic-field-generating device (x40),

same side of a feedpath have the same polarity, which is opposed to the polarity of the magnet(s) on the opposing side of the feedpath, b) a linear permanent magnet Halbach array, c) one or more pairs of two bar dipole magnets, wherein each of said two bar dipole magnets has its magnetic axis substantially parallel to the substrate (x10) surface and wherein the two bar dipole magnets have an opposite magnetic direction, d) one or more pairs of two bar dipole magnets (x41a, x41b), wherein each of said two bar dipole magnets has its magnetic axis substantially perpendicular to the substrate (x10) surface and wherein the two bar dipole magnets have an opposite magnetic direction or e) a U-shaped magnet.

8. The process according to any preceding claim, wherein the platelet-shaped magnetic or magnetizable pigment particles are platelet-shaped optically variable magnetic or magnetizable pigment particles selected from the group consisting of platelet-shaped magnetic thin-film interference pigment particles, platelet-shaped magnetic cholesteric liquid crystal pigment particles, platelet-shaped interference coated pigment particles comprising a magnetic material and mixtures of two or more thereof.

9. The process according to any preceding claim, wherein the substrate is selected from the group consisting of papers or other fibrous materials, paper-containing materials, glasses, metals, ceramics, plastics and polymers, metalized plastics or polymers, composite materials and mixtures or combinations thereof.

10. A printing apparatus comprising a transferring device (TD), preferably a rotating magnetic cylinder (RMC), and at least one of the second magnetic-field-generating devices (x40) recited in any one of claims 1 to 8, said transferring device (TD), preferably said rotating magnetic cylinder (RMC), comprising at least one of the first magnetic-field-generating devices (x30) mounted thereon and recited in any one of claims 1 to 9.

11. The printing apparatus of claim 10 further comprising a substrate-guiding system.

12. Method of manufacturing a security document or a decorative element or object, comprising:

a) providing a security document or a decorative element or object, and

b) providing an optical effect layer according to the process of one of claims 1 to 9 so that it is comprised in the security document or decorative element or object.